Contains an abstract only.

BULLETIN No. 7.

Department of Agriculture,

Gold Coast.

YEAR-BOOK

1926.

Issued by

The Honourable the Director of Agriculture.

GOLD COAST.

Government Printer, Accra.
1927.

CONTENTS.

Paper No.	Subject.	Writer.	Page
1	The Department of Agriculture and the Agricultural Industries 1926	C. H. Knowles	7
2	Oil-palm Plantation Industry in Sumatra and Malaya	G. G. Auchinleck	12
3	Effects of Cultivation on Wild Oil-palms	C. Saunders	16
4	Extracts from Report on Oil-palms at Odumase	F. N.Howes	21
5	Notes on Structure and Classification of Oil-palm Fruits	G. G. Auchinleck	24
6	Records of the Mycological Division 1926	R. H. Bunting	27
7	Local Cereal Diseases in the Records of the Mycological Division ..	R. H. Bunting	29
8	Factors determing the Incidence of Cacao pod diseases	H. A. Dade	32
9	Notes on Termites in the Gold Coast	W. H. Patterson	39
10	Life-history of *Sahlbergella singularis* and *Sahlbergella theobroma* ..	G. S. Cotterell	44
11	A new parasite of *Sahlbergella singularis*	G. S. Cotterell	48
12	A new parasite of *Heliothrips rubrocincta*	G. S. Cotterell	51
13	Trials with Efwatakala Grass at Kumasi	T. Hunter	53
14	Report on the Accra Sisal Plantation	J. M. Wingate	55
15	Yields of Cola at Kumasi Experiment Station	T. Hunter	60
16	Trials with Limes in the Central Province	J. Steele	65
17	Methods of Cultivation and uses of Food-crops	E. M. Cook	72
18	Report on Cotton Selection in British Togoland	F. N. Howes	80
19	Recent Work on Relation between Stock and Scion	G. G. Auchinleck	93
20	School Gardening	T. Hunter	99
21	Rainfall of the Gold Coast for 1925 and 1926	J. M. Adams	105

ILLUSTRATIONS.

No.			Legend.	Paper No.
Plate	*I.*	figs.	A,B,C, Abepa Oil-palm Fruit	5
			D,E,F, Abepa Oil-palm Fruit	,,
			G,H,I, Abedam Oil-palm Fruit ..	,,
			J,K,L, Abetuntum Oil-palm Fruit ..	,,
Plate	*I.* (b)		A,B,C, Abetuntum-Abobobe Oil-palm Fruit	,,
Plate	*II.*	figs.	A,B,C, Abetuntum-Abobobe Oil-palm Fruit	,,
			D,E,F, Multiple-kernelled Oil-palm Fruit	,,
Plate	*III.*	figs.	A,B,C, Deli Oil-palm Fruit	,,
			D,E,F, Lisombe Oil-palm Fruit ..	,,
			G,H,I, Diwakkawakka or Mantle type of Oil-palm Fruit	,,
Plate	*IV.*	fig.	C, *Sphaerostilbe* (?) *repens* on Lime roots	6
			H, *Macrophoma sp.* on Cacao pod ..	,,
Plate	*V.*	fig.	I *Ganoderma lucidum* on Cassava	,,
Plate	*VI.*	fig.	K Stripe disease of Cacao pods ..	,,
Plate	*VII.*	fig.	A *Epicoccum neglectum* on Maize-leaves	7
Plate	*VIII.*	fig.	B, *Acrothecium lunatum* on Sugar-cane	,,
			B 1 *Acrothecium lunatum* on Guinea-corn	,,
			D,E, *Oospora sp.* from root of Maize ..	,,
			F, *Cephalosporium acremonium* on Maize..	,,
Plate	*IX.*	fig.	G *Helminthosporium sp.* on maize leaves	,,
Plate	*X.*	fig.	J *Botryodiplodia theobromæ* on Maize	,,
Plate	*XI.*		1 & 2 Adults of *Sahlbergella singularis* and *S. theobroma*	9
Plate	*XII.*		1—6 Egg and Nymphs of *Sahlbergella theobroma*	,,
Plate	*XIII.*		1 & 2 Damage to Pod and bark by *Sahlbergella*..	,,
Plate	*XIV.*		Knapsack dusting-machine at work..	,,
Plate	*XV.*		New parasite of *Sahlbergella singularis*	10
Plate	*XVI.*		New parasite of *Heliothrips rubrocincta*	11
Plate	*XVII.*		Yields of Cola Trees at Kumasi	14
Plate	*XVIII.*		Lint Chart of Gold Coast and Togoland Cotton	17
Plate	*XIX.*		Garden of Wesley College, Kumasi	19

PAPER No. I.

THE DEPARTMENT OF AGRICULTURE AND THE AGRICULTURAL INDUSTRIES, 1926.

By C. H. Knowles, B.Sc. (Lond.).
Director of Agriculture.

Cocoa Prices.

A record has again been established for the export of cocoa which reached 225,920 tons for the calendar year 1926. The whole of the main crop season has been characterised by high prices, which reached a point never attained since the boom years of 1919 and 1920.

Sanitation.

The work under the Plant Sanitation Scheme was found to be quite satisfactory so far as eradication of pests was concerned, but very slow and therefore costly. It was considered necessary to change the methods of procedure. Under the new system the duties of the Inspectors are to give to farmers near each town demonstrations of the methods to be applied to the farms where the declared pests exist. This enables each Inspector to cover a comparatively large area and the whole of the cocoa areas will be covered in a reasonable time. The farmers have then to apply the methods shown at the demonstration. After a lapse of six months the Inspector can visit the farms in the areas in which demonstrations have been given and institute proceedings against farmers who have failed to apply the necessary measures, while at the end of twelve months the Inspector can do the necessary work with employed labour at the expense of the farmer. Work has progressed on the whole very smoothly and the demonstrations have been well attended.

An interesting investigation was carried out by Mr. H. A. Dade, on the incidence of disease in pods. It was necessary to follow the main crop right through from small pods and information as to the complete history of a crop has thus been obtained. An outline of the investigation is included in the Year Book.

The export of cocoa forms a steady drain on the mineral resources of the soil, for nothing is added to the soil by the farmer to replace the loss. The use of artificial manure is unknown, and the effects of the use of suitable manures have so far not been certain. With the view of commencing to obtain information on this important point, manurial experiments were laid down during the year on several of the Stations of the Department.

Oil Palms.

Mr. G. G. Auchinleck, Deputy Director of Agriculture, during the year has visited Java, Sumatra and the Malay States to investigate the oil-palm industry. A valuable and interesting report has been submitted and is being published separately, while some notes are included in the Year Book.

It is quite clear that, if this country is to compete with the countries where the oil-palm industry is an organised plantation industry under the supervision of highly trained officers and with the most modern machinery into which every improvement is introduced as soon as possible, we shall have to follow the same procedure. The local industry, which comprises the preparation, by crude methods, of small quantities in a large number of centres in oil-palm belts, will probably always continue to supply local demands, but even there some improvement is possible. Sets of hand-power machinery have been obtained and are used for demonstration purposes at suitable centres. The machinery consists of a kettle for steaming the fruits, a machine for removing the pericarp from the nuts, a screw-press for pressing the oil from the pulp, and a machine to crack the shells of the nuts. The oil produced by the use of this machinery is of a much superior quality to that produced by the usual crude methods.

The plantation system would have to be established on a large scale. In the East, 12,000 acres is regarded as the minimum area for a modern mill. This means the use of a correspondingly large amount of capital. There are certain difficulties here, but it is considered that these difficulties are not insuperable.

Cotton.

The encouragement of cotton cultivation in the Northern Territories was decided upon during the year and since funds were provided in the middle of the year the scheme has been actively pursued.

Cotton has always been cultivated by the people in the Northern Territories for their own purposes, and was found as a pure cultivation in many cases by the writer during a visit at the end of 1925. There are therefore none of the difficulties attendant upon the introduction of a new crop. The steps taken were to introduce from Nigeria cotton seed of a good strain likely to suit the country, to guarantee a price for the clean, mature seed-cotton the produce of that seed, to build a ginnery and to establish a farm where trials with and selection of cotton may be carried out. The people have readily taken up the seed offered to them. There are practically no exports of any kind at present from the Northern Territories and cotton-growing seems perfectly suitable for the purpose of establishing one. Stores will almost certainly follow where the people can satisfy their desires for an improved standard of living which will surely develop.

The ginnery is now in course of erection and it remains to be seen what the results are. The present season (1926-27) unfortunately has not been a good one, and the crop will be much less than anticipated but the establishment of an industry does not depend on the results of one season, so it will be some time before any definite statement can be made, but the future of the industry is contemplated with considerable confidence.

Coconuts.

The Department's plots along the coast have steadily progressed. The 300 acres at Atuabo in the Western Province are now rapidly coming into bearing. Arrangements have been made for the construction of drying apparatus, store rooms, &c.

At each plantation it is proposed to erect dryers both for drying by exposure to the sun and by artificial heat. The former will consist of trays running on rails, arranged so that they may rapidly be run under cover one under the other at night time or in case of rain, while the artificial dryer will be constructed of concrete and will consist of a chamber, containing trays on which the material to be dried is placed. A current of warm air passes through the chamber by natural draught. Either of these dryers can be constructed from materials readily obtainable in the country. Details of construction and results obtained will be published in due course.

Sisal Hemp.

The Accra Sisal Plantation has had a successful year. The working costs have gradually been brought down, while the quality has been improved by the installation of more efficient brushing machinery and a baling-box to take fibre full length. The output of fibre in the calendar year 1926 has exceeded the estimate of 400 tons. But the growth of the young plants used to replant the older areas and the replanting itself was interfered with owing to want of rain. An offer to buy the plantation and mill, to take over from the Government its interest in the sisal industry, to extend considerably the area planted and to continue to encourage the people in the vicinity to plant sisal, made early in 1926, is not yet settled.

Limes.

The encouragement of lime planting near Abakrampa in the Central Province has been quite successful. The area planted has been more than was originally asked for and the plants are receiving careful attention and have grown well.

A site for a lime-juice factory has been selected and the matter now must wait until the plants are reaching the bearing stage, when Messrs. Rose and Company, Ltd., have promised to erect a factory.

Rice.

It has been decided that any encouragement given to rice-growing should be only for swamp-rice, not the upland varieties. As swamp-rice growing is not an industry here, Mr. C. Saunders, Provincial Superintendent of Agriculture in the Western Province, was instructed to break his journey at Sierra Leone on returning from leave, for the purpose of investigating swamp-rice growing which is an industry of very considerable magnitude. Since returning Mr. Saunders has visited parts of the Western Province and found areas of land which seem suitable for the purpose. Seed is being secured from Sierra Leone and the growing of swamp-rice will be tested during the coming season.

The rice-mill has at last been completely equipped and adjusted and is now ready for use. During the last year or so the people have not been growing as much rice as they usually do, but now that the mill is ready to turn out rice in any desired state of preparation and in considerable quantity, it is believed that the people will take proper advantage of it.

Fruit.

Samples of bananas, grape fruit, oranges, limes and coconuts, &c., were sent to the Director, Gold Coast Commercial Intelligence Bureau, London, who used them for exhibit at the Imperial Fruit Exhibition 1926.

As this was the first time fruit from the Gold Coast had been exhibited at an Exhibition of this sort, it attracted considerable attention. Considering that proper facilities for sorting, grading and packing the fruit did not exist here, and the lack of previous experience, the fruit turned out in very satisfactory condition. Further trial shipments especially of grape fruit are arranged for. The grape-fruit is reported to have a fine and distinct flavour and appears to offer most possibilities. A careful examination of local fruit trees is being made for the purpose of selection and propagation of the best fruit.

Rubber.

The export of rubber reached a very satisfactory total, and there is no doubt that the Para rubber industry can be very successfully followed in West Africa. The increase is of course due to the increased prices of the last two years and, given stability of these prices, the interest in the industry will not only be maintained but is likely to increase.

An interesting feature is the manufacture of Funtumia latex into sheet rubber and the discouragement of its manufacture into balls or any other form. When prepared with care, Funtumia sheet appears to be quite a satisfactory product.

Organisation.

The Department of Agriculture work in connection with the above products, and the general routine of the Department have followed the same lines as in previous years. Certain defects in the organisation of the Department which have been noticeable for some time have at last been made the basis for a reorganisation of the Department. Proposals are now being drafted to enable investigations into agricultural problems to be more expeditiously carried out, to ensure accuracy and to put the special training of the highly qualified officers to better use.

PAPER No. II.

THE OIL-PALM PLANTATION INDUSTRY IN SUMATRA AND MALAYA.

By G. G. AUCHINLECK, M.Sc., F.I.C.,
Deputy Director of Agriculture.

The Eastern plantations of oil-palms are being described fully in Bulletin 8 of the Department of Agriculture. The present paper gives a brief summary of the position in 1926.

Areas.

The areas planted in oil-palms have increased regularly during the past few years.

Year.	*Area under cultivation.*	
	Sumatra.	*Malaya.*
1915	6,500 acres.	10 acres.
1920	22,400 ,,	1,125 ,,
1921	24,250 ,,	2,067 ,,
1922	30,600 ,,	2,460 ,,
1923	38,000 ,,	4,320 ,,
1924	46,800 ,,	6,544 ,,
1925	60,350 ,,	9,694 ,,

In 1926 the normal annual increase in acreage of about 25 per cent may be expected on established estates, and in addition three companies have taken up new land-concessions for 120,000, 100,000, and 50,000 acres respectively with a view to future plantings if the industry proves to be a commercial success.

Types Grown.

The average composition of the Deli type is as follows :—

	% *Bunch.*	% *Fruit.*
Kernel-oil	1.9	4.2
Kernel-fibre	1.8	4.1
Shell	14.1	32.2
Pericarp-oil	13.2	30.0
Pericarp-fibre, moisture, etc.	13.0	29.5
Whole fruit	44.0	100.0
Stalks, bracts, etc.	56.0	
Whole bunch	100.0	

The Deli type originally came from West Africa. It is being gradually improved in composition by careful, skilled selection in Sumatra. The selection is aimed at increase in yield of oil per tree and per acre, and at an increase in thickness of pericarp with corresponding lessening of the thickness of shell. The removal of palms of low yield from the plantations and their replacement by selected types is a matter of ordinary estate routine.

Field Methods.

Germination of seed is speeded up by different devices, and it is claimed that 80 per cent germination can be attained in 2 to 3 months instead of the normal 60 per cent in 12 to 14 months. The best method in Sumatra is to soak the seed for 7 or 8 days in water, the water being warmed three times daily to a temperature of 45° to 50° C (113° to 122° F). Recently, equally good results have beeen claimed in Malaya by germinating in sand-beds covered with a glass frame.

The young plants are set out in the fields in triangular fashion at a distance of 9 metres (29.2 feet) apart. Clean-weeding has been shown to have disastrous results, and the land is therefore covered with leguminous green-dressings or left unweeded, the weeds being periodically cutlassed back.

The earlier practice of cutting away all leaves up to the bunches of fruit is now condemned. Dead or damaged leaves are removed, but the leaves immediately below the fruits are not removed until after the bunches have been reaped.

Artificial pollination has been proved to give greatly increased yields, but the resultant heavy crops are too great a burden on young palms. This procedure has therefore been discontinued on most estates, although it will probably be revived in moderation when systematic manuring begins to augment the strength of the palms.

Yields.

The palms begin to bear at $2\frac{1}{2}$ to 3 years of age. The mean yields of several estates in Sumatra and Malaya are given as follows :—

Age of Palms.	*Pounds of pericarp-oil per acre.*	
5 years ..	260	mean of 5 Sumatra Estates
6 „ ..	441	„ „ 10 „ „
7 „ ..	682	„ „ 10 „ „
8 „ ..	962	„ „ 9 „ „
	1,343	one Malaya Estate
9 „ ..	1,130	mean of 7 Sumatra Estates
10 „ ..	1,083	„ „ 7 „ „
11 „ ..	927	„ „ 6 „ „

The decline in yield after 9 or 10 years is stated to be due to the facts that many early mistakes in cultivation have been committed, and that systematic manuring has been started only within the past year.

Several cases of high yields have been recorded from estates. In 1925 an estate in Sumatra of 410 acres of 11-year old palms averaged 1919 pounds of pericarp-oil per acre. Other cases of high yields were obtained from an estate in Malaya.

		Pounds pericarp-oil per acre.		
Field No.	*Acreage.*	*Sixth year*	*Seventh year.*	*Eighth year.*
4	60	2,555	2,284	2,100
1	20	—	1,622	2,130
10	80	—	1,721	2,190

It is probable that an average yield of three-quarters of a ton of oil per acre will eventually be attained in Sumatra and Malaya, as methods of cultivation and manuring improve.

These figures may be compared with the following figures obtained from groves in the Gold Coast in 1924/25.

Locality.	*Acreage.*	*Yield of pericarp-oil : pounds per acre.*
Eastern Province	.. 15 acres	340
Central Province	.. 15 ,,	192
Western Province	.. 70 ,,	156

These figures are based on the assumption that 20% of the weight of fruit is obtained as pericarp-oil.

Factory Methods.

Several fine, modern factories have been erected in Sumatra in the past three years by Messrs. Krupp & Co., of Germany. The capacity of these factories is usually 10,000 tons of pericarp-oil output per annum each. The cost appears to be in the neighbourhood of £10 capital per one ton of oil output, so that a factory turning out 10,000 tons of oil per year would cost £100,000 to erect.

In general, the factory processes include
(a) steam-sterilization of whole bunches,
(b) double-pressing of fruits in hydraulic presses
(c) benzene-extraction of residual oil in fibre.

In the most recent factories, the railway trucks with their loads of bunches are run into the steam-steriliser, six at a time, and steam forced in. The oil from these factories can be produced with a maximum acidity of 1 to 3 per cent., (free fatty acid) owing to the rapid and efficient sterilization.

In no case in Sumatra has the centrifugal method of separating the oil from the fruit been retained. It is claimed that centrifugalling yields 24 per cent of the weight of fruit in oil, against 29 to 30 per cent obtained by the hydraulic press and benzene extraction.

Broken shells are separated from kernels by means of an elutriator which works in clean water, and the old, inefficient and dirty clay-bath method will eventually disappear.

Transport of Oil.

The cost of casks for packing the oil is very high. One estate in Malaya reports that total charges work out as follows :—

Plantation and factory costs £6 per ton of oil.
Casks for packing £6 per ton of oil.
Transport to coast and to Europe £6 per ton of oil.

To reduce this charge for packages, the oil in Sumatra is being railed to the coast in 7-ton cylindrical waggons, and there discharged into large tanks to await shipment.

Plans are being worked out for shipment of the oil in bulk by tank-steamers, but up to 1926 these arrangements had not been perfected. There is no serious technical difficulty to be anticipated, however, and it is probably only a matter of a year or two before all oil will be exported in bulk.

PAPER No III.

THE EFFECTS OF CULTIVATION ON WILD OIL-PALMS IN THE WESTERN PROVINCE.

By C. SAUNDERS, N.D.A., N.D.D.,
Provincial Superintendent.

In late years attention has been drawn to the declining interest taken in the oil-palm and the palm oil industry of this Colony, and various suggestions have been made as to means by which the industry could be restored to its former importance.

These suggestions, generally, have been prompted from the manufacturing standpoint, with the view of making the best use of the fruit obtained by present methods, and turning out a superior commercial oil by means of mechanical extraction.

There is little doubt that this is essential to enable the industry to compete in the world's markets, where a higher grade oil is demanded than that usually prepared by the hand process. This side of the industry requires modernising, and to be brought up to date.

The stock-in-trade required for mechanical extraction is, of course, costly to purchase and costly to maintain, and if such an undertaking is to be worked economically, large and almost constant supplies of palm-fruits must be forthcoming.

By the old methods of extraction the work could be carried on in a casual and intermittent manner, but such is not suitable for the modern specialised means of extraction.

Conditions in Western Province.

In the Western Province we are favoured by having a modern factory situated within the palm belt, but with that aid all is not plain sailing; difficulties are being experienced in keeping up constant and sufficient supplies of fruit.

The Province is rich in natural growth of the oil-palm. From the eastern boundary to the Nyan River there is a zone, several miles in depth, where the oil-palm predominates over other forest growth. This is gradually extending. As the heavy timber forest retreats inland its place is taken by palm growth. Farther to the west, wherever conditions are suitable, and in many inland areas

where the forest has been cleared of heavy timber for firewood, the oil-palm is found to be taking a prominent place. It is also found throughout the forest areas of the Colony and Ashanti. What has been said about the Western Province can be applied with little modification to each of the other Provinces of the Colony.

With this wealth of natural growth, the Gold Coast should occupy a very strong position in the oil trade, and be able to maintain it against any competition; yet the industry has dwindled from one of importance.

The cause is not difficult to understand, and in the main is due to :—

(a) The competition of other forms of employment.

(b) Difficulties connected with collection of palm fruits.

(c) The laborious and wasteful methods of making oil by the hand process.

The object of this paper is to throw some light on the difficulties there are in collecting the large quantities of fruit under existing conditions, and to suggest some means by which increased returns may be obtained for the labour involved.

Factors Affecting Yields.

At present, the work of gathering fruit is difficult, and there is much waste in time and labour wandering through the palm bush in search of fruit. Much of this could be avoided if some—even rough method of cultivation were adopted.

The palm in its natural state is found growing in a tangled growth of low bush with which it is in constant competition for all that is essential for growth.

Any plant growing under such conditions could be expected to be a poor producer of fruit.

To the casual observer it is evident what a small percentage of palms are found to be fruiting, and to what extent the collector must search the bush to obtain any quantity of fruit, and having found it, what work there is in connection with gathering it.

Palms vary considerably in their fruiting capacity. Some appear to produce nothing but male inflorescences, others exclusively female inflorescences and eventually fruit.

Others again appear to bear fruit during one season and male inflorescences the next. Of the fruiting palms some will be found to be producing only one bunch in the season whereas another may be seen carrying 8 bunches at a time, and probably giving a second crop in the season.

Every variation is to be found; as to what extent these variations are due to some physiological character of the individual palm, and to what extent due to external influences brought about by local conditions it is difficult to say, at present, but undoubtedly, light,

air and moisture play a very prominent part. When this is understood, it will be realised that though a palm area may be well stocked with palms yet the return in fruit from it may be very small, or vary considerably from season to season.

Yields of Trial-Plots.

At the Government Oil Palm Plantation, Anaji, two plots of 20 acres each of natural palm bush have been under observation and the yields recorded, since July, 1924, and the small return of fruit obtained from them is surprising.

These returns have been worked out to yield per acre, and are set forth in the table opposite, where a comparison is also made with another plot of 50 acres of similar palm land which has been cleared of all growth except palm and receives a rough kind of cultivation (semi-cultivation).

These yields are in pounds of bunches per acre.

In 1924 a census was made of the palms.

Plot " B " had an average of 53 palms of fruiting age per acre and 51 over 2 years and not then of fruiting age per acre.

Plot " D " an average of 49 palms of fruiting age per acre. and 52 over 2 years and not then of fruiting age per acre.

Many of these young palms should now be of fruiting age.

As these observations have been carried on for $2\frac{1}{2}$ years, they can be taken as giving fairly reliable information as to the amount of fruit to expect from an area of natural palm growth, and the advantages of cultivation.

The average yield per month during the 30 months they have been under observation, is as follows :—

Plot " A ".	121.9 lbs average per acre, per month.
Plot " B ".	43.3 lbs average per acre, per month.
Plot " D ".	35.1 lbs average per acre, per month.

This shows fairly clearly to what extent the oil palm will respond, even to a rough form of cultivation.

In comparing the yields of the above table it will be noticed that there was very little difference between the yields of plot " A " and " B " during the first 12 months, but immediately the palms could show the benefit of the changed conditions in terms of fruit, the yields of plot " A " forged ahead, until now the average yield per acre is near the ratio of $7\frac{1}{2}$ to 1 for the last 12 months.

COMPARISON OF YIELD PER ACRE BETWEEN PLOT "A" (UNDER SEMI-CULTIVATION) AND PLOTS B & D (IN THE NATURAL STATE).

WEIGHT OF BUNCHES PER ACRE.

1924.	"A"	"B"	"D"	*Rainfall.*
July	—	—	—	4.18 inches
August	21.8 lbs. per acre.	17.7 lbs. per acre.	—	0.30
September	31.2 ,, ,,	8.8 ,, ,,	18.9 lbs. per acre.	1.12 ,,
October	59.4 ,, ,,	35.3 ,, ,,	8.8 ,, ,,	8.66 ,,
November	84.6 ,, ,,	15.9 ,, ,,	12.7 ,, ,,	3.04 ,,
December	177.4 ,, ,,	74.1 ,, ,,	73.9 ,, ,,	4.65 ,,
	374.4	151.8	114.3	
1925.				
January	215.6 ,, ,,	147.0 ,, ,,	109.2 ,, ,,	—
February	194.3 ,, ,,	190.0 ,, ,,	101.9 ,, ,,	1.32 ,,
March	177.5 ,, ,,	106.4 ,, ,,	252.0 ,, ,,	3.40 ,,
April	72.8 ,, ,,	67.2 ,, ,,	108.4 ,, ,,	2.79 ,,
May	189.8 ,, ,,	204.3 ,, ,,	177.1 ,, ,,	3.43 ,,
June	Nil	Nil	11.2 ,, ,,	25.08 ,,
July	52.0 ,, ,,	28.0 ,, ,,	Nil	12.26 ,,
August	76.7 ,, ,,	21.0 ,, ,,	Nil	1.22 ,,
September	106.9 ,, ,,	16.8 ,, ,,	5.5 ,, ,,	2.19 ,,
October	71.7 ,, ,,	51.8 ,, ,,	1.1 ,, ,,	2.09 ,,
November	126.5 ,, ,,	16.8 ,, ,,	Nil	0.31 ,,
December	114.8 ,, ,,	51.8 ,, ,,	8.9 ,, ,,	1.50 ,,
	1,398.6	901.1	775.3	
1926				
January	222.3 ,, ,,	51.8 ,, ,,	27.4 ,, ,,	0.66 ,,
February	257.0 ,, ,,	39.7 ,, ,,	47.0 ,, ,,	0.50 ,,
March	311.7 ,, ,,	80.1 ,, ,,	48.1 ,, ,,	1.50 ,,
April	251.7 ,, ,,	16.2 ,, ,,	20.1 ,, ,,	1.42 ,,
May	180.5 ,, ,,	6.1 ,, ,,	8.9 ,, ,,	11.20 ,,
June	148.0 ,, ,,	7.2 ,, ,,	2.2 ,, ,,	13.81 ,,
July	9.9 ,, ,,	2.8 ,, ,,	Nil	0.89 ,,
August	49.8 ,, ,,	Nil	Nil	0.17 ,,
September	98.0 ,, ,,	5.5 ,, ,,	Nil	3.99 ,,
October	86.2 ,, ,,	9.8 ,, ,,	Nil	3.93 ,,
November	103.6 ,, ,,	8.4 ,, ,,	2.8 ,, ,,	1.52 ,,
December	165.7 ,, ,,	19.6 ,, ,,	7.0 ,, ,,	
	1,884.4	247.2	163.5	

[If we assume that the weight of the fruit is 50 per cent. that of the bunches, and that 25 per cent. of the weight of fruit is recoverable as pericarp-oil, the yields for the years 1925 and 1926 of these plots are as follows:—

	Pounds of pericarp-oil per acre. 1925.	1926.
Plot A	175	235
,, B	113	31
,, D	97	20

On the plantations in Sumatra, the usual yield of pericarp-oil per acre recovered and shipped, ranges from half a ton to one ton.—EDITOR.]

Conclusions.

If the palm bush in the near vicinity of the villages were to receive only such attention as would relieve the palms of shade and entangling bush growth the yields could be reasonably expected to be trebled, with a corresponding decrease in labour connected with collection. The oftener a palm is worked, the easier the collection becomes.

Unfortunately under the communal system it is no one's business to try and improve the palm bush where any is free to gather, but the lesson is there for any one willing to benefit by it.

The best fruiting palms are generally to be found on old farming areas, where in course of the cultivation of other crops, the palms have been thinned out and freed from competition with bush growth, benefiting by the cultivation given to the area in connection with the growth of other crops.

Unfortunately in clearing for new farms the thinning is carried too far, and many valuable palms are needlessly destroyed.

Much can be done to improve these farm areas, where a type of individual ownership is recognised.

When new farm lands are being prepared, a selection should be made of the palms, and those retained which are good fruiters, and spaced at intervals of 30 feet. Palms with stems 7 to 8 feet high are more suitable, and more useful than the tall palms usually left standing.

If the palms are trimmed up, the under-grown crop will suffer little harm from shade. Any open spaces there may be, should be planted with palm nuts at the time the first crop is put in.

These nuts should be obtained from a good fruiting palm, and about 10 nuts placed in each hole,—the plants resulting to be thinned out later. By the time the farm is abandoned, and allowed to revert to bush, these young palms will have got ahead of other growth and will be able to maintain their lead.

By this means the abandoned farm lands will be turned into valuable palm areas, yielding far larger returns than could be obtained from an equal area of virgin bush, and from which fruit could be collected with far less labour.

Another interesting point that is brought out by the Table given is how the highest yields of fruit occur at periods of low rainfall, or in other words the apparent effect a high rainfall has on the palms at the time the fruit is setting, as shown in the larger yields obtained 6 months or so later.

PAPER No. IV.

EXTRACTS FROM THE REPORT ON OIL-PALM WORK AT ODUMASE

OF F. N. HOWES, M.S.C., F.L.S.,
Formerly Botanist to Department.

Thin-Shelled Palms.

On arrival at Odumase in June, 1926, steps were taken to isolate and mark thin-shelled palms. In all, some 30 such palms have now been found, these forming a basis for pollination work : of these, five are in Plot B, and the remainder in Plot A. Thin-shelled palms were isolated by taking samples of, and examining fruit from bunches as they ripened on the palms.

Thin-shelled fruit is very different in structure to thick-shelled. On the whole, thin-shelled fruit is smaller and more elongated than the thick-shelled, though no marked difference appears to exist in the size of the bunches ; bunches of thin-shelled fruit quite as large as any of the thick-shelled having been noticed. A very marked feature about thin-shelled fruit is the small size of the nuts, which are spherical, and not uneven in shape or pointed, as often are the thick-shelled forms. Another feature is the depth of pericarp and fibre that exists in the fruit at the bases of the nut : a strong contrast to thick-shelled forms where, apart from the apical end, pericarp and fibre are more or less evenly distributed round the nut. This feature renders possible as a rough and ready means of spotting thin-shelled nuts, biting or cutting with a knife the basal end : if the " nut " appears close to the surface the fruit is thick-shelled, if well away from the surface, thin-shelled.

Samples of fruit from each thin-shelled palm have been preserved for reference and for comparison later with their offspring, should they be used as parents.

In addition to the 30 thin-shelled palms already marked, there are undoubtedly many others present in the plantation which it is proposed to isolate in a subsequent visit. Undoubtedly it would be desirable to have recorded the fruit yielded by these thin-shelled palms, and so pick out in time the heavy yielders from the medium and low yielders. Such figures, compared with those already being recorded on the plantation, would also give indication as to whether thin-shelled palms yield normally more or less fruit than thick-shelled : a large number of palms, 30 or more, being necessary for figures of this sort to be of value.

The following two sets of figures prepared by the Agric. Chemist from fruit forwarded from Odumase illustrate the main differences in composition of thick and thin-shelled fruit :—

	Thin-Shelled.		*Thick-Shelled.*	
Pericarp ..	68.52		28.79	
Nuts ..	31.48		71.21	
	100.00		100.00	
Oil	32.45		10.19	
Shell ..	16.88		44.39	
Moisture ..	19.71	per cent. fruit.	12.49	per cent. fruit.
Kernel ..	13.63		26.10	
Fibre ..	16.37		6.11	

From these figures it is seen that the thin-shelled form possesses a far greater percentage of pericarp and oil, and in consequence the percentages of fibre and moisture are higher and the percentage of kernel much less.

.....

.....

Varieties at Odumase.

At Odumase the variety with fruit green when young instead of black (Twi name "*Abedam*") appears to be very common : much more so than is the case in the Anaji area in the Western Province. Classifying the bunches collected from day to day at Odumase pointed to the occurrence of the different varieties being approximately as follows :—

Thin-shelled forms.	Green form (Abedam).	Ordinary forms. (Abepa, Abetuntum).
6%	19%	75%

In Plot B a thin-shelled form of "Abedam" (one palm only) was observed. This form has not been seen elsewhere and is apparently very rare. A solitary specimen of the "Fetish" or "King" oil-palm also exists in plot B. (*Abehene* Twi *Lalota* Krobo). This is the only variety amongst the oil-palms that has a distinct vegetative appearance : the crown possessing a very shaggy appearance owing to leaflets lacking rigidity and being at a greater angle to the main axis than the other forms.

The mantled type of oil-palm (Diwakkawakka) would appear to exist in Krobo in the Bisa area, judging from information obtained and from actual specimens of fruit procured by the Konor of Odumase from near Bisa. This locality and Kpandu are the only two areas where this interesting form has so far been located : in both areas its occurrence is said to be very rare. No former record of its occurrence on the Gold Coast can be found. Seed of this form obtained from the District Commissioner, Kpandu, has been planted at Aburi.

The Krobo names for the different varieties of oil palm have been found to be as follows.—Twi equivalents given :—

Twi.	*Krobo.*	*Ewe*.*
Abepa	Wie-Kpa-Kpa ..	Degba
Abetuntum	Wie-Yumu	Deyibo
Abedam	Wie-Hlem	Blede
Abobobe	Wie-Wiam	Aduye
Abehene	Lalota	Klode.

[*The Ewe names were obtained by Mr. A. W. Paterson after Mr. Howes' departure from the Colony. They are the names used in Togoland. The name "KLODE" is used for the Diwakkawakka or "Mantle" type, which is doubtfully reported identical with Abehene. For the present all these names should be regarded as merely provisional.—EDITOR.]

PAPER No. V.

NOTES ON THE STRUCTURE AND CLASSIFICATION OF OIL-PALM FRUITS.

By G. G. AUCHINLECK, M.Sc., F.I.C.,
Deputy Director of Agriculture.

Very little work has been done on the examination and classification of local types of oil-palms. Like many other important matters, this has had to be postponed until an adequate botanical staff has been provided for the Department, and in the meantime we have to rely, for information concerning one of our own crops, on the work of better equipped Departments in the Dutch and British East Indies.

The local classification of oil-palms is based on the colour, shape and structure of the fruit. It is a rough method, and there are wide variations within each recognised type, so that it appears practically impossible to find two palms the fruit of which are exactly alike. The four main types recognised and named locally are :—

Abepa.—(Plate I. figs A, B, C and D, E, F).—Small angular or asymmetrical fruits which ripen a bright yellow-red colour. The proportions shell : kernel : pericarp differ from palm to palm.

Abedam.—(Plate I. figs G., H, I).—Long, ovate fruit which ripen a bright yellow-red colour with a pale-green upper extremity. Proportions shell : kernel : pericarp vary from palm to palm.

Abetuntum.—(Plate I. figs. J, K, L and Plate I.(b) Figs A, B, C).—Ovate, symmetrical fruit, usually of fair size, which ripen to a dark, chocolate-brown colour. Proportions shell : kernel : pericarp vary from palm to palm.

Abehene.—(No specimens secured).—One palm of this type exists at Odumase, Gold Coast. It is doubtfully reported to be of the " mantle " type, that is a compound fruit formed by union of several sterile, oil-bearing flowers around a central fruit. The leaflets are characteristic, lying parallel to the mid-rib with points forward, so that the foliage-crown is quite different in appearance to other types.

In each of these four types there are found individuals which have very thin shells. These thin-shelled sub-types are known as Abobobe, so that there are Abedam-Abobobe, Abepa-Abobobe and so forth. The type shown in Plate II. figs. A, B, C and Plate I.(b) figs A, B, C, are Abobobes of the Abetuntum type.

Normally the oil-palm fruit contains one kernel only, but fruit are frequently found with 2, 3 or 4 kernels. These do not constitute different types but are merely individual variations occurring on the same palm and in the same bunch as normal one-kernelled fruits. As a matter of interest, illustrations of Abedam doubles, triples and quadruples are given in Plate II figs. D, E, F.

Sumatra Types.

The types in Plates I., I(b) and II. were found in the course of a short inspection of the groves at Odumase, Gold Coast. They do not pretend to be complete, and serve merely as the starting point for work on isolation and classification of local types in other parts of the Gold Coast. There is room for a book on the question.

In Plate III. figs. A, B, C, D, E, F, G, H, I, are shewn three types recognised in Sumatra. The illustrations are drawn from A. A. L. Rutgers' " Investigations on Oil Palms. " 1922, and are useful for comparative purposes.

The types figured are as follows :—

Deli.—The standard type on which the whole of the new plantation industry in Sumatra and Malaya has been founded. This type is supposed to have originated in West Africa, but so far has not been found in the Gold Coast.

Lisombe.—A thin-shelled type, which should be a useful starting-point for selecting a strain yielding a high percentage of pericarp-oil.

Mantle.—Known as Diwakkawakka. Possesses a mantle of sterile, oil-bearing flowers massed round a central fertile fruit. Palms of the " mantle " type seen in Java did not show the unusual arrangement of foliage which is said to be characteristic of the Abehene type.

In 1924/5 a series of determinations was made by the Department Chemist, Captain R. Coull, of the average composition of fruits of five local types. The results are given below, with the addition of figures for the Sumatra Deli type for purposes of comparison.

PERCENTAGE COMPOSITION OF FRUIT. MEAN OF TEN SAMPLES OF EACH TYPE.

	Abepa.	Abedam.	Abetuntum.	Abobobe.	Abefita.	Mean for Deli type (Rutgers).
Pericarp-oil ..	21.1	20.7	16.8	33.0	17.7	30.0
,, fibre ..	9.2	9.1	9.4	12.2	7.3	
,, moisture	18.3	17.5	14.1	22.3	14.9	29.5
Shell	37.2	40.1	46.5	19.3	44.1	32.2
Kernel	14.2	12.6	13.2	13.2	16.0	8.3
Whole fruit ..	100.0	100.0	100.0	100.0	100.0	100.0

The Abefita type is not figured in this paper.

Very large variations in the percentage-composition were found, shewing that the local types are not constant in constitution. The extreme variations found among the ten samples of each of these five variations were as follows :—

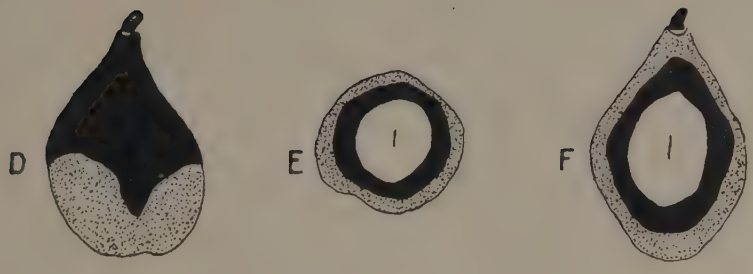
% Fruit	Abepa	Abedam	Abetuntum	Abobobe	Abefita
Pericarp-oil	13.0 to 32.1	8.7 to 39.6	8.1 to 31 7	29.0 to 37.7	13.2 to 22.2
Fibre ..	5.7 to 14.7	2.5 to 15.9	6.1 to 16.0	9.4 to 18.2	4.9 to 9.5
Moisture ..	8.2 to 22.4	9.0 to 25.9	5.5 to 25.6	13.8 to 21.1	7.2 to 18.6
Kernel ..	12.4 to 44.3	25.4 to 45.2	18.4 to 49.4	.8 to 28.2	28.9 to 44.5
Shell ..	7.2 to 26.1	5.6 to 19.2	8.7 to 21.1	7.6 to 17.4	9.7 to 22.2

Conclusion.

It is hoped that this brief article will shew the need for a careful examination of all local types and for selection and propagation of those strains which promise to be of unusual value commercially.

Work of this sort cannot be systematically continued by officers burdened with routine administrative and investigational work, but unusual types of fruits can be marked and held over for description and classification at some future date when necessary technical staff has been provided by the Government.

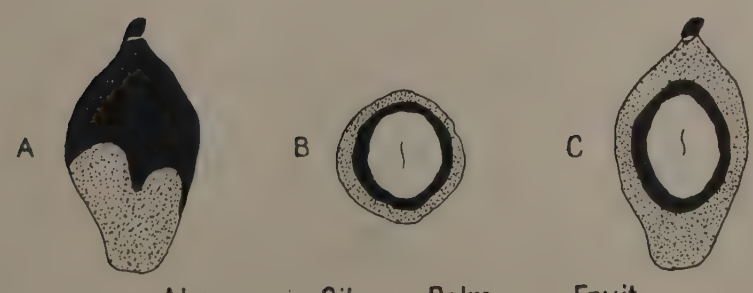
PLATE I



Abepa Oil Palm Fruit

Abedam Oil Palm Fruit

Abetuntum Oil Palm Fruit

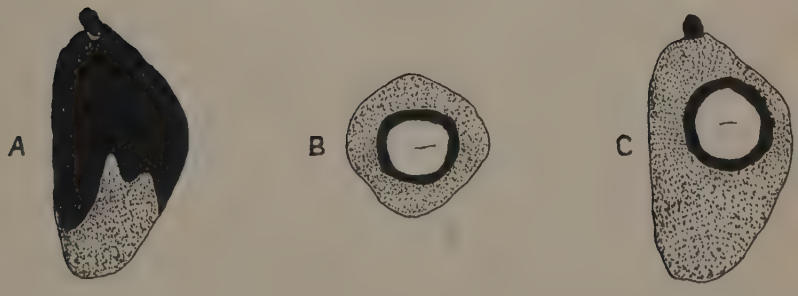


Abepa Oil Palm Fruit

Reproduced at Survey H.Q. Accra, 1927.

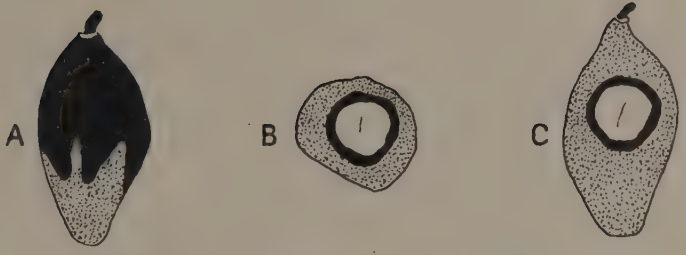
PLATE IB

Abetuntum - Abobobe Oil Palm Fruit.

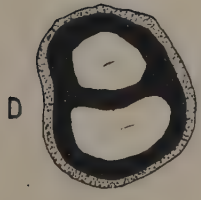


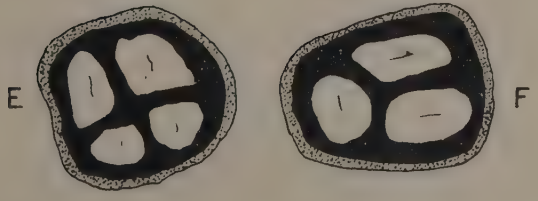
Reproduced at Survey H.Q. Accra, 1927.

PLATE II



Abetuntum-Abobobe Oil Palm Fruit

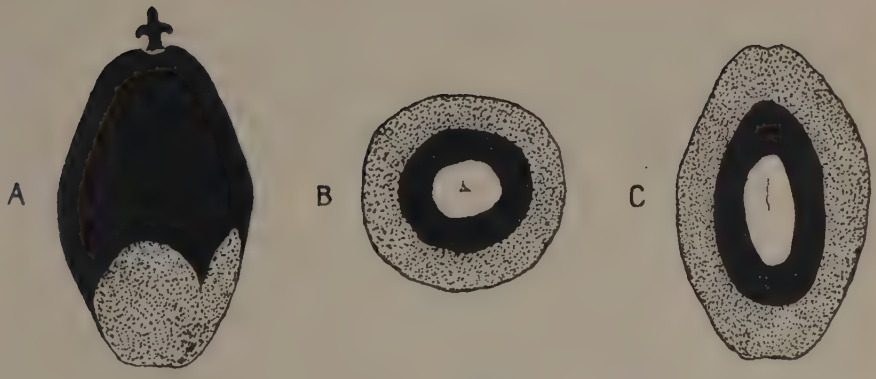




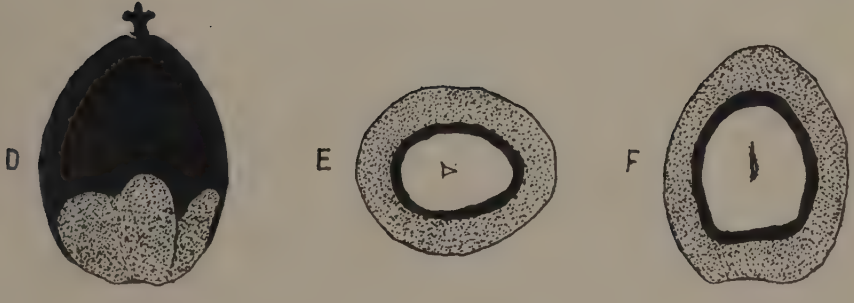
Multiple-Kernelled Oil Palm Fruit
(Abedam Type).

Reproduced at Survey H.Q. Accra, 1927.

PLATE III



Deli Oil Palm Fruit



Lisombe Oil Palm Fruit

Diawakkawakka or Mantle Type of Oil Palm Fruit

Reproduced at Survey H.Q. Accra, 1927.

PAPER No. VI.

EXTRACTS FROM RECORDS OF THE MYCOLOGICAL DIVISION 1926.

By R. H. BUNTING, F.L.S.,
Assistant Director for Research and Mycologist.

Lime Tree Diseases.

Whilst preliminary investigation of moribund lime-trees in the Central Province resulted in the record of three diseases, it was apparent that the absence of soil-cultivation was largely responsible for the condition of the ten-year old trees.

A number of cases of red-root were found bearing the conidia and rhizomorphs of a *Sphærostilbe* (probably *repens*). Conidial fructifications, rhizomorphs and perithecia (Plate IV. fig. C.,) were also found in masses on a heap of decomposing fruit.

In association with a root-rot, characterised in its early stages by the localised decomposition of affected cortex, there was found in every case a red brown to dark purplish mycelial thread capable of penetrating the soil for many inches without support. No fruiting bodies were found, and efforts to induce infection of young lime-tree roots at Aburi have been unsuccessful. The ultimate condition of an affected root was a sodden mass of decomposed tissue frequently demarcated by scales of the yellow, persistent epidermal tissue.

Cases of die-back too severe to be successfully treated were considered to be directly due to uncongenial soil conditions, they bore numerous saprophytes and in one case *Diplodia*, differing from *Botryodiplodia theobromæ* in size of spores, appeared to be causal.

Stripe Disease of Cocoa Pods.

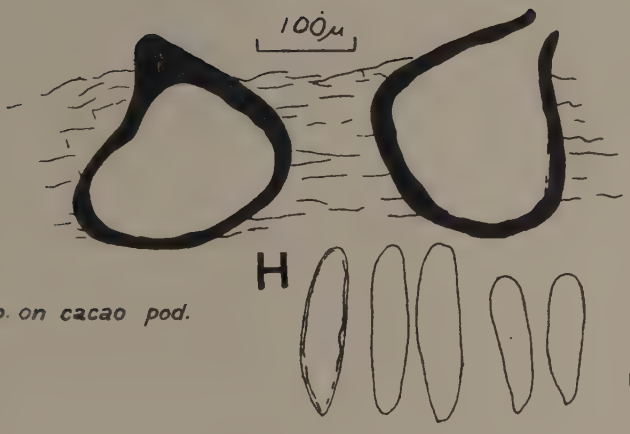
The symptoms of this diseases are external blotchy, reddish brown to black discolorations, arranged longitudinally along ridges on the surface of pod exposed to maximum light; internally the lesions, confined to the pericarp, are at first water-logged in appearance, becoming reddish-brown then slatey and mucilaginous, when they are demarcated by a black border. The sections in Plate VI. figure K shows the disposition of the lesions. The whole pericarp ultimately becomes black and rotten. A bacterium found in the characteristic lesions of this disease is considered to be the wound parasite—*B. aroideæ* Towns.

Other new Records.

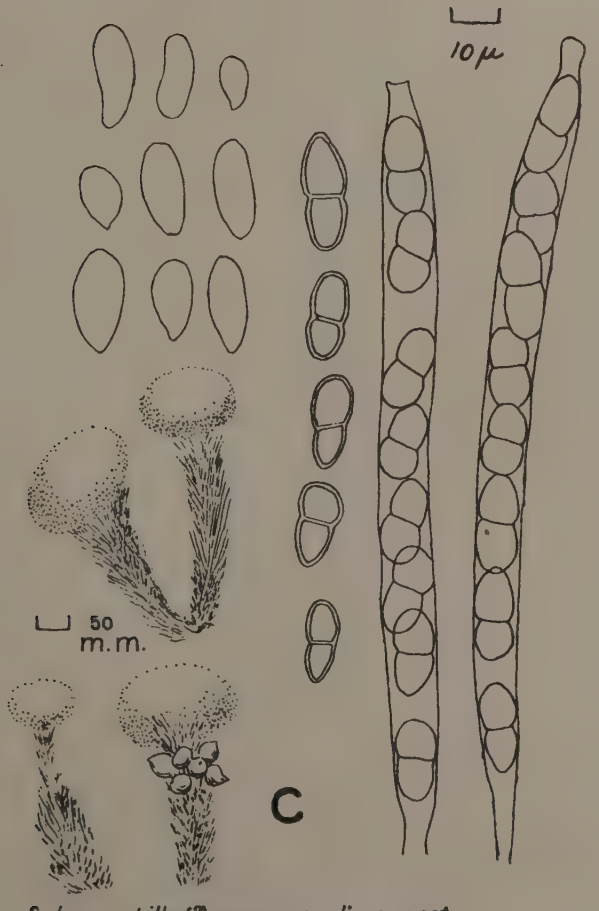
New records of diseases or fungi other than those mentioned above or under " Local Cereal Diseases " are :—

Thielaviopsis paradoxa van Holm on Coconut palms Kumasi.
Ganoderma lucidum Karst. on Cassava, Ejura (Plate V. fig. I.)
Macrophoma sp. on Cocoa pods, Kumasi (Plate IV. fig. H.)
Macrospora sp. on Cotton leaves, Seikwa and Sampa.
Macrosphærella ? *gossypina* on Cotton leaves, Kumasi.

PLATE IV



Macrophoma sp. on cacao pod.



Sphaerostilbe(?)repens on lime roots.

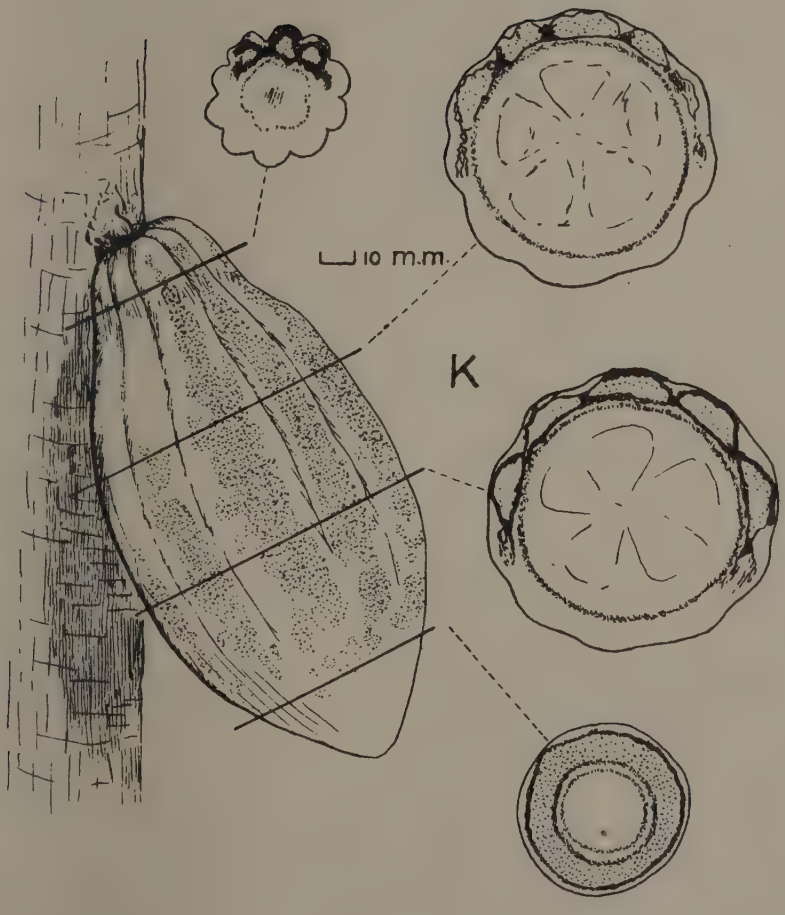
Reproduced at Survey H.Q. Accra 1927.

PLATE V

Ganoderma lucidum on cassava.

Reproduced at Survey H.Q. Accra 1927.

PLATE VI



Stripe disease of cacao pods.

Reproduced at Survey H.Q. Accra 1927.

PAPER No. VII.

LOCAL CEREAL DISEASES IN THE RECORDS OF THE MYCOLOGICAL DIVISION.

By R. H. BUNTING, F.L.S.,
Assistant Director for Research and Mycologist.

Investigation of the fungi affecting cereal crops has opened up a number of problems requiring elucidation. Of these, the degree of pathogenicity, and the relative economic importance of several fungi, which occur on the staple food crop—maize—, are of interest, as is the question of the possible toxicity to consumers of corn affected by some of the moulds. Species especially requiring attention include *Oospora* (possibly *verticillioides*), *Fusarium* (probably *moniliforme*), *Diplodia macrospora* Earle, *Cephalosporium acremonium* Corda, *Acrothecium lunatum* Wakk., *Basisporium gallarum*.

The frequent occurrence in maize-farms of *Acrothecium lunatum* on leaf-spots, which differ from those caused by the conidial stage of *Ophiobolus heterostrophus* Drechsler chiefly by the occurrence of a translucent central spot, led to an attempt to test the possible pathogenicity of that fungus. The results are not conclusive, but an *Oospora* (Plate VIII. fig. D.), closely resembling the description of *O. verticillioides*, resulted from the inoculation of a maize-seedling—grown on sterilised soil from disinfected seed—with a mildew which developed on separation plates sub-cultured from an *Acrothecium* leaf-spot.

Cultures derived from a case of ear-rot of maize in which the upper part of the host-plant had collapsed by rotting, developed a *Fusarium* considered to be *F. moniliforme* Shel. A suspension of the macroconidia of this fungus was applied to an aseptically cultivated maize seedling, and an *Oospora* (Plate VIII fig. E.), developed, which, whilst morphologically similar to that from the leaf-spot mentioned above, presented certain cultural differences. Opportunity to repeat the tests on a sufficiently large scale is awaited.

Cephalosporium acremonium Corda (Plate VIII. fig F.), has been developed in culture from the discoloured vascular bundles of the peduncle of a nubbin (aborted) cob.

When dehusking cobs of Hickory King corn at Kumasi during the first crop of 1926 a few ears were found to contain greenish-grey to jet-black grains (Plate X. fig. J.), the latter were scattered in groups of 1 to 3 and were found to contain a mass of mycelium

consisting of dark brown, rather thick-walled hyphæ; sub-epidermal pseudostroma bearing several pycnidia were found in the grey grains; the shanks were infested with the same type of mycelium as occurred in the grains and indicated that infection had taken place by the cut end. The fungus agrees with *Botryodiplodia theabromæ* Pat. and has developed typical lesions on cocoa pods.

Acrothecium lunatum Wakk. has been found on the glumes of *Andropogon sorghum,* and on the leaves of *Saccharum officinale* (Plate VIII. figs. B1 & B).

The occurrence of a species of *Marasmius,* believed to be undescribed, parasitic on the leaves of maize, has again been recorded.

A rust—apparently *Puccinia purpurea* Cooke—has been collected on *Andropogon sorghum.*

The following is a list of graminaceous hosts and fungi which have been collected locally :—

Andropogon gabonese Stapf :—

Puccinia sp.

Andropogon Gayanus var. bisquamulatus Hack :—

Capnodium sp.,
Cercospora sp.,
Sphacelia sp.

Andropogon halepense :—

Helminthosporium turcicum Pass.

Andropogon Sorghum L. (Guinea Corn) :—

Acrothecium lunatum Wakk. (Plate VIII. fig. B1);
Cercospora Sorghi E. & E.,
Colletotrichum andropogonis Zimm.,
Puccinia (prob. *purpurea* Cke.),
Sphacelotheca Sorghi Client.

Imperata arundinacea (Lalang) :—

Puccinia rufipes Diet. frequently parasitised by *Darluca filum.*

Mariscus umbellatus :—

Cintractia axicola var. *minor* Client.

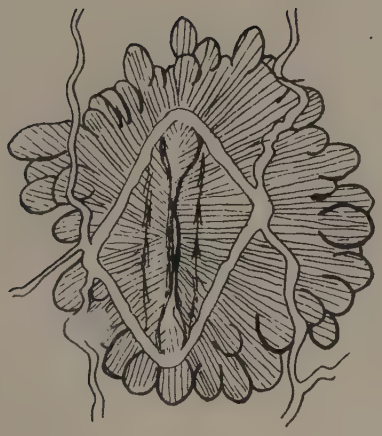
Melinis minutifolia (Efwatakala grass) :—

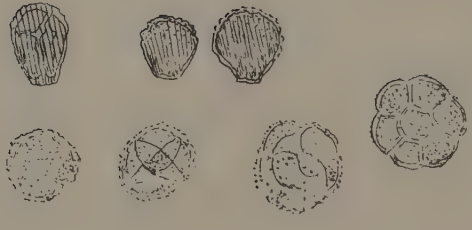
Sclerotium sp.

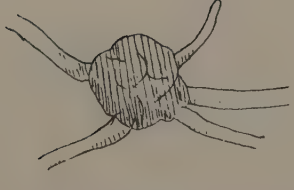
Oryza sativa L. (Rice) :—

Alternaria sp.,
Helminthosporium oryzæ B. de H.,
Nigrospora oryzæ Petch.,
Piricularia oryzæ Br. & Cav.

PLATE VII





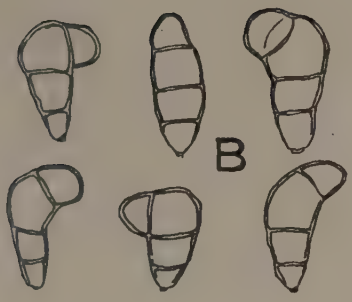


Epicoccum neglectum on Maize-leaves.

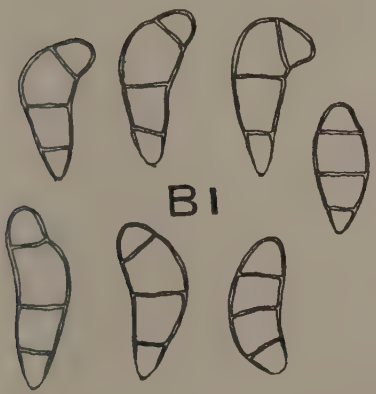
A ⌴ 10 μ

Reproduced at Survey H.Q Accra 1927.

PLATE VIII

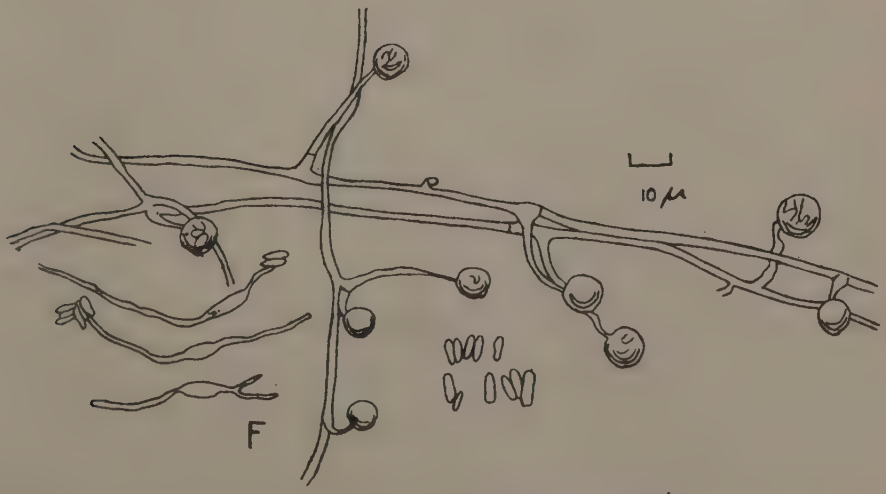


Acrothecium lunatum on Sugar-cane.



Acrothecium lunatum on Guinea-corn.

Oospora sp. from root of maize.



Cephalosporium acremonium on maize.

Reproduced at Survey H.Q. Accra 1927.

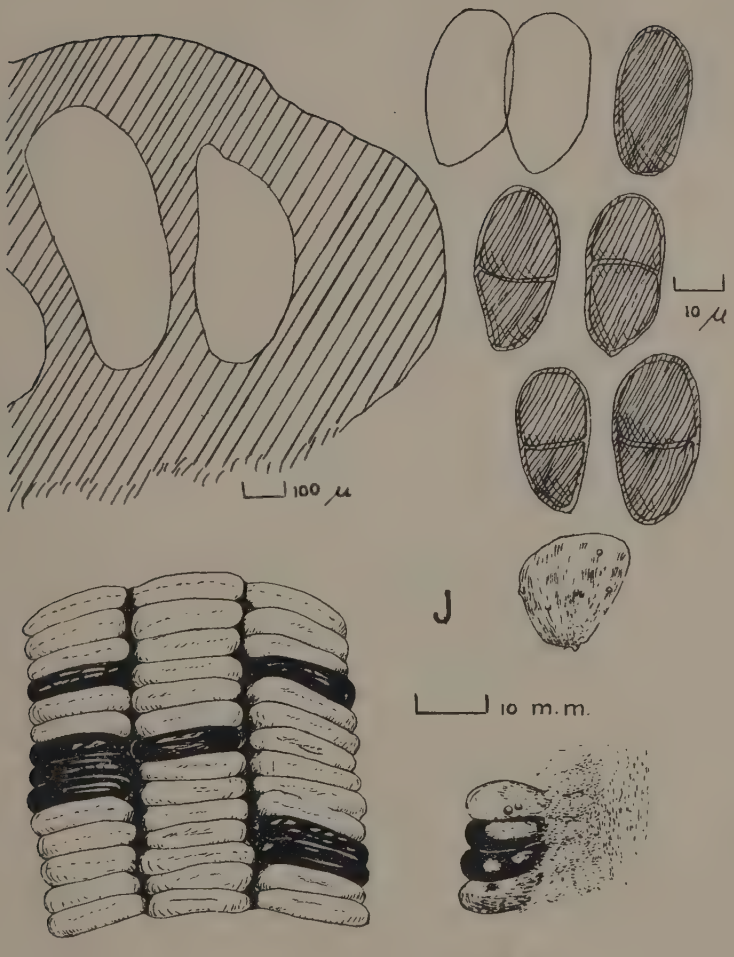
PLATE IX

Helminthosporium sp. on maize leave.

Reproduced at Survey H.Q. Accra 1927.

10 μ

PLATE X



Botryodiplodia theobromae on maize.

Reproduced at Survey H.Q. Accra 1927.

Panicum maximum :—

Fusarium heterosporum Nees.,
Phyllachora heterospora Henns.,
Ustilago heterospora Henns.,

Pennisetum setosum :—

Cerebella cenchroidis Subram.

Pennisetum typhoideum L. (Bulrush Millet) :—

Helminthosporium sp.,
Puccinia penneseti Zimm.,
Sphacelia sp.,
Tolyposporium penicillariæ Bref.

Rottboelia exaltata :—

Helminthosporium sp.,
Puccinia sp.

Saccharum officinale (Sugar Cane) :—

Acrothecium lunatum Wakk. (Plate VIII. fig. B.)
Helminthosporium sp.,
Leptosphæria sacchari B. de H.

Setaria sulcata Radd. :—

Ustilaginoidea sp.

Sporobolus pyramidalis :—

Epichloe cinerea B. & Br.,
Helminthosporium Ravenelii Curt.,
Marasmius sp.

Urochloa insculpta Stapf :—

Puccinia sp.

Zea mays (Maize) :—

Acrothecium lunatum Wakk. (syn. *Helminthosporium curvulum* Sacc.),
Basisporium gallarum,
Botryodiplodia theobromæ Pat. (Plate X. fig J.),
Cladosporium sp.,
Clasterosporium maydicum Sacc.,
Diplodia macrospora Earle,
Epicoccum neglectum Desm., (Plate VII. fig. A.),
Fusarium (? *moniliforme*.),
Helminthosporium turcicum Pass.,
H. aff. *rostratum* (Plate IX. fig. G.).
H. aff. *sativum*,
Marasmius sp.,
Ophiobolus heterostrophus Drech. (conidial stage only).
Papularia sphærosperma (Pers.) v. Holm,
Pestalozzia sp.,
Phoma zeicola El. & Ev.,
Physoderma zeæ-maydis Shaw,
Puccinia maydis Ber.,
Ustilago zeæ Ung.

PAPER No. VIII.

FACTORS DETERMINING THE INCIDENCE OF DISEASES OF CACAO-PODS.

(Briefly abstracted from Bulletin No 6 of the Department of Agriculture, in which complete data are available.)

By H. A. DADE, A.R.C.S., *Mycologist.*

A preliminary detailed investigation of cacao pod diseases was undertaken at Anyinam in 1926 in order to obtain definite information from native farms. Such information was not previously available, the only existing records being those of agricultural stations.

At Anyinam, which is situated in the Birim valley in Akyem Abuakwa, an area providing conditions particularly suitable for cacao cultivation, the incidence of pod diseases was known to be very severe. Farms in this district fall into distinct classes, characterised by different conditions of water relation according to their situation on the banks of the river or on higher ground, and according to their relative degrees of lateral and overhead protection. In this brief summary it will suffice to say that from the point of view of the principal factor affecting the incidence of disease —atmospheric humidity—the farms may be classified as of high (excessive), medium and low humidity. From the point of view of the protection of the host plant from the annual drought they may be classified as excessively, sufficiently, and insufficiently protected. The two sets of classes are more or less, but not, necessarily, coincident.

A number of experimental plots were marked out in farms representing each type. The pods on the trees within seven feet from the ground, which it was possible to examine closely, were labelled as they were set, and carefully observed throughout their life, a complete and separate record being kept of each pod. The history of the farms, conditions of shade, drainage, etc., were studied, and meteorological observations were made throughout the season.

Relative Significance of Pod Parasites.

In the farms under observation 55.4 per cent of the total crop was infected by pod diseases. Meteorological conditions in 1926

were less favourable to disease than normal. Different fungi were responsible for these infections, as follows :—

Phytophthora Faberi—" Black Pod "	40.5%
Botryodiplodia theobromæ—" Pod Rot "	6.2%
Colletotrichum sp.—" *Anthracnose* "	0.3%
Trachysphæra fructigena " Mealy Pod "	0.1%
Undiagnosed	8.3%
	55.4%

(Undiagnosed cases were those in which pods were reaped before diagnosis was complete. They were ovviously due, the majority to P. Faberi, most of the remainder to Colletotrichum.)

Phytophthora Faberi is, of course, the most important pod parasite. Anthracnose is rather more common than was suspected. The anthracnose fungus—*Colletotrichum sp.* prob. *Cradwickii,* is commonly found as a secondary parasite or saprophyte on diseased pods and husks, and is also found on immature cast-off pods. *Trachysphæra fructigena,* while an efficient parasite of the fruit of Liberian coffee, appears to be only a weak parasite of cacao. It is however found growing very luxuriantly on husk-heaps. *Botryodiplodia theobromæ* appears to be much less important in the Gold Coast than in other cacao-growing countries.

Factors Determining the Incidence of Black Pod Disease.

Humidity.—Of the various conditions which influence the incidence of Black Pod disease, that of atmospheric humidity is the key factor. Records of Relative Humidity were made by reading wet and dry bulb thermometers at 7. a.m. and 2. p.m. in various situations, thereby obtaining a rough but fairly representative idea of conditions of atmospheric humidity during the night and day respectively. Pod records, from observations made twice a week, provided data showing the percentage of healthy pods which became infected during each half-week period. A graphic representation of these results appears in Bulletin 6. In this chart the humidity curve has been set forward 5 days to allow for the incubation period which elapses between actual infection and the first visible symptom—discolouration of the pod. This period occupies from 2 to 8 days, according to the nature of the infection, which progresses more rapidly when it takes place through a wound than when it occurs on a sound pod.

It will be seen that the night humidity curve is fairly flat, which is what we should expect, for in the forest belt the saturation point is reached soon after sunset, and is probably nearly always maintained until dawn. The day humidity curve fluctuates very considerably. In two places on the chart, at H and T, the day humidity is consistently high for a period of a few days, and at these times the incidence-curve rises correspondingly. The minor fluctuations also correspond.

Phytophthora Faberi requires a saturated atmosphere, or a film of water on the pod, for the successful germination of sporangia or zoospores, and infection. Such conditions occur during nearly every night of the bearing season, but in the day only when the Relative Humidity remains high and evaporation from the surface of pods is retarded. This correlation of sustained high humidity and the incidence of infection is clearly shown in the graph in Bulletin 6.

Transmission.—Cacao trees are visited by numerous insects, and these are probably the chief agents of wide transmission. Cultures of *P. Faberi* have been obtained from the feet of insects taken in cacao farms and allowed to walk over the surface of sterile medium in culture tubes. To some extent other animals, and particularly man, also transmit disease. A high degree of incidence occurs in trees by the side of tracks, where spores are carried on the clothing of passersby from diseased to sound pods.

Local Transmission.—It is well known that disease is transmitted by rain or dew-drops falling from diseased to healthy pods on the same tree, and by contact between sound and diseased pods.

In the former case it was found, as might be expected, that the percentage of total infections associated with drip is directly proportional to the relative degree of humidity of the farm. That is, a much greater percentage of the total infections were associated with drip in farms in the high humidity class than in other classes.

On the other hand. about 25 per cent of the total infections were associated with contact between healthy and diseased pods in each humidity class. Here we have a factor dependent on the morphology of the host, and independent of the relative degree of humidity of the farm.

In each case other factors which might affect the data have been examined, which indicate that they do not actually complicate the issue.

Site of Infection.—The influence of the morphology of the host plant was clearly proved. The proportions of proximal, lateral and distal infections were found to be remarkably constant in all the farms, despite the very different conditions prevailing in them.

In each case other factors which might affect the data have been favourable conditions of humidity. Such conditions may be general throughout the farms and in all parts of the pod during the night, but during the day such conditions, while they depend primarily on the degree of atmospheric humidity, are sustained in definite regions of the pod for long periods. Drops of water are retained by surface tension at points where pods are in contact with the trunk or with other pods, and also in the proximal depression surrounding the insertion of the peduncle, and as drips in the distal or lateral regions, according to the posture of the pod. The chances of such retention of water are greatest in the proximal region and least in the distal

region. At these points moisture is held and does not evaporate for a long time, often remaining throughout the day. In the neighbourhood of these drops of water conditions suitable for infection are maintained for long periods, and here the majority of infections take place.

Injury.—Other conditions being constant, damage to the epidermis of pods facilitates infection, although it is by no means a *sine qua non,* for *P. Faberi* is a very efficient parasite and is not dependent upon wounding for its infections. Surface wounds expose the nutritive tissues which otherwise can only be reached by the infection hypha after it has bored through the epidermis. Moreover the exudation of mucilage assists in the retention of moisture which would normally be shed by the waxy cuticle.

Analysis of the various types of injury shows that the wounds which are most frequently followed by infection are those caused by man (cutlass and knife wounds) and pod-borer, the damage done in these cases being extensive. The other insect pests which damage pods are principally Thrips, Helopeltis and Sahlbergella sp. The two former principally infest exposed farms, or parts of farms, *i.e.,* situations where shade or other conditions which affect the constitution of the cacao tree in relation to drought are bad. In such situations atmospheric humidity is comparatively low, and little pod disease occurs. In excessively humid farms such insect damage as occurs causes a higher incidence of infection, but in these farms little damage occurs. With regard to Sahlbergella, attacks by which are not related to conditions of humidity, there is not yet sufficient evidence to show whether the wounds caused by these insects have any considerable influence in the incidence of disease. In dry exposed farms infested with Thrips and Helopeltis statistics shows that there is actually a less degree of infection in wounded pods than in sound ones, but this is because the pods most subject to insect damage are those borne in exposed positions where atmospheric humidity is low.

In farms on which cacao is suitably protected and conditions affecting its well-being are well-balanced, injury appears to have no appreciable effect on the incidence of disease.

Husk-heaps.—Heaps of discarded husks, such as are found in all native farms, have always been suspected as centres of infection during the bearing season, and as nurseries in which disease is carried over from one season to the next.

Much evidence in this case has been collected, and it indicates that husk-heaps as centres of infection are of negligible importance. In the West Indies, in fact, some planters have after trials, decided that sanitary treatment of husk-heaps is not a sound economical proposition.

A few only of the facts elicited by observation need be mentioned here. Figures collected during the season show that there is no definite difference in the percentage of incidence of disease in zones of farms remote from and near to husk-heaps. The first

infections which occurred this season were not related to the site of husk-heaps. In old husk-heaps very few viable spores of *P. Faberi* are present, and it is extremely difficult to obtain a culture from this source.

In fresh husk-heaps *P. Faberi* cannot compete with saprophytes and *Trachysphæra fructigena,* which overrun the husks. Spores of *P. Faberi* are therefore present in comparatively small quantity. At the time when husk-heaps are formed there are numbers of diseased pods on the trees with the fungus in active sporulation, and such pods form an infective agency sufficient to produce all the infections which occur, an agency infinitely superior, on account of their distribution and activity, to husk-heaps. Moreover, from 50 to 70 per cent of the total infections in the farms studied occurred before the formation of new husk-heaps. A study of the economics of the problem shows that the expense of any form of treatment of husk-heaps is out of all proportion to the very doubtful advantage, if any, which may be gained.

Diseased Cushions.—The problem of the means by which the carrying over of disease from one season to the next is accomplished is to some extent solved by the fact that many infections have been found to occur through the peduncle from diseased cushions. Such cushions, exhibiting when opened typical symptoms of canker, were found to be associated with a number of the earliest infections recorded, and with many infections during the season.

Cushion infections account for some of the proximal infections referred to in considering site of infection, but for what proportion is not yet known.

Comparative significance of factors.—A review of all the factors directly affecting the incidence of Black Pod disease shows that, of the total infections studied— over 5,000—the proportions associated with each factor are :—

1.	Contact	25 per cent.
2.	Drip	11 per cent.
3.	Lateral and distal morphology	21 per cent.
4.	Proximal morphology ...	43 per cent.
5.	Diseased cushions	
6.	Injury	trace.
		100

The first four factors could undoubtedly be considerably reduced by controlling the growth of the cacao tree. In native farms its growth is not controlled, and close planting induces the formation of a long trunk on which contact between pod and pod, and pod and trunk is at its maximum. The encouragement of an orchard habit, with a short trunk and a few main limbs, greatly reduces the possibilities of contact, drip and retention of moisture by surface

tension. The production by plant breeding of a strain of Amelonado cacao characterised by a slightly modified morphology would also further decrease incidence of disease to a probably negligible degree.

With a considerable lowering of incidence the further infection of cushions would be automatically reduced, for diseased cushions are undoubtedly the result of previously diseased pods.

The Effect of Disease on the Market Product.

The quality of prepared cocoa is principally determined by the efficiency of fermentation, drying and storage. Pod disease also affects quality to some extent, (i) by the destruction of the mucilaginous tissue surrounding the beans, which supports the yeasts of fermentation; (ii) by the effect of the products of fungus metabolism in which the beans are soaked; (iii) in advanced cases by the actual invasion of the beans themselves by the parasite.

In the first case fermentation experiments show that unless a very large percentage of the fermentation mass is infected, fermentation proceeds normally. That is, the mucilaginous tissue provided by the sound beans present is sufficient for the fermentation of the whole mass.

The effect of fungus excretions on the cotyledons is not yet known.

Some evidence has been collected which indicates that the occurrence of internal moulds in the beans is facilitated by pod disease, although this serious defect is primarily due to incomplete drying or imperfect storage.

Some idea of the cocoa prepared at Anyinam in 1926 was obtained. A number of typical reapings, each yielding about 5 cwts. of dried cocoa, were analysed during the season. It is not possible to estimate the condition of the beans by the appearance of the unbroken pod, and these analyses were made by classifying the beans as each pod was husked.

Very little of the crop was actually lost—*i.e.*, discarded by the farmer, but a great deal of the cocoa prepared was damaged by disease. The " badly damaged " class is that in which the pods were blackened, shrivelled, and more or less dry and hard, while the mucilaginous tissue is either brown and dry, with the beans adhering in clumps, or broken down into black slime. In the latter case the beans are soft and easily crushed between the fingers. There can be little doubt that the quality of such badly damaged cocoa is adversely affected. The " partly damaged " cocoa is that from pods partly or wholly discoloured (brown) in which the mucilaginous tissue is becoming brown, with a tendency to dryness and to adherence of beans.

Thus, while pod disease causes very little actual loss of crop in native industry, it probably has a considerable effect upon quality. At the present time this causes no considerable loss of income to

the farmer, but in the event of a change in market conditions, such as may be expected, the effect of pod disease on quality may assume a greater economic significance.

Effect of Environment on the Periodicity of Cacao.

A remarkable difference in the periodicity of cacao in two types of environment was observed at Anyinam, where some cacao is grown on alluvial riverside flats, subject to annual floods, while other farms are established on higher ground. In the heavily shaded and laterally well-protected farms by the river the main crop is produced and ripened about seven weeks before that of the upland farms. In the former farms the main crop was set from the middle of January to the end of February, and reaping began in the middle of July. In the upland farms fruit was set from the middle of March to early in April, and reaping began in September. In all farms the mid-season crop has become reduced to negligible proportions.

This phenomenon is undoubtedly the result of different conditions of water relation during the dry season. The trees in the upland farms exhibit the periodicity which is normal throughout the country. In the riverside farms, which are very thoroughly sheltered, and in which the water table remains relatively high during the dry season, the physiological processes of the trees are not inhibited by a serious annual drought, and they are able to resume their seasonal activity earlier in the year than are trees in less favoured farms.

Minor variations in periodicity within each class were definitely associated with variations in the environmental factors which determine water relation during the dry season.

Production per Acre in Native Farms.

Our only source of definite information as to yields of cacao in the Gold Coast has been the records of agricultural stations, in which conditions are very different from those in native farms. Careful observations of production on native farms of all types and ages at Anyinam in 1926 showed that the farms produced from at least 8 to 15 cwts. of dry cocoa per acre, the average figure being 11 cwts. (These figures represent the lowest estimate possible, and in every case some of the crop was not included in the counts owing to small reapings which escaped observation.)

These yields are considerably higher than we have previously supposed was the case in native cultivation. They are higher than those of most agricultural stations, but the yields shown in station records do not include the crop " lost " through disease, which is estimated at from 3 to 20 per cent. On stations a great deal of cocoa is discarded which would be included in the crop by a farmer.

Repeated trials showed the number of pods per pound of dried cocoa to be from 6.9 to 10. In agricultural stations the highest record is 8.6, the lowest 20.6. The largest pods were produced in riverside farms.

PAPER No. IX.

NOTES ON TERMITES IN THE GOLD COAST.

(Abstracted in Head Office from a Report of W. H. PATTERSON, M.B.E., *Entomologist*,).

In October 1925, a Bulletin (No. 1) of this Department was issued, in which the Entomologist made suggestions for the control of Termites. Since then increasing attention has been paid to the identification of these insects, and the following notes are therefore printed in continuation of the subject.—(Editor.)

The following species of termites have been determined by Professor Sjostedt :—

1. *Neotermes aburiensis* Sjost. sp.n. Aburi, 58, 63, from old wounds in cacao trees, having no runways connecting with the soil.

2. *Neotermes sp.n.* Aburi, 67, from living wood in cacao stem, having attacked through a wound. No runway connecting with the soil.

3. *Neotermes sp.n.* Aburi, 68, from similar position to No. 2.

4. *Glyptotermes parvulus* Sjost. Aburi, 69, 71, 72. The first number was from a dry, rotten portion of a cacao branch still attached to the tree, the second from a wound in a living cacao stem, the third from very moist, living tissue of a cacao branch.

5. *Schedothinotermes putorius* Sjost. Aburi, 88, from wide runways up the trunk of *Ficus elastica* previpusly much injured by the larvae of the cerambicid beetle *Pectognatha gigas* F. Stem of tree much injured by this termite. Similar injury to Flamboyant tree through neglected wound.

6. *Termes (Amplitermes) bellicosus,* Sm. Aburi, 59, a large mound-forming species.

7. *Termes pauperans Silv.* Aburi, 84, 90. This spreads over the surface soil under cover of runways. The nest is subterranean with fairly large fungal gardens and is not easily located.

8. *Termes sudanensis* Sjost. Aburi 85, attacking fallen branches on surfce of soil, nest subaterranean.

9. *Bellicositermes goliath* Sjost. Keta 76. Wide runaway on surface of soil to feed upon debris of wood and vegetable matter. Coming up through crevices in concrete at District Commissioner's court with mound nest beneath bungalow near by.

10. *Termes (Odontotermes)* sp. Aburi, 61, from surface of soil feeding on dead stems.

11. *Microtermes splendens* Sjost. sp.n. Kedji Keta, 79, from the centre of a coconut palm stem, 3 feet above ground, possibly the site of an old wound of rhinoceros beetle.

12. *Enstermes lacifrons* Sjost. Kumasi 73, from old stem wounds in cacao trees; Atitite 81, in dead spathe on a young coconut palm; Atitite 82 from a runway on stem of coconut palm.

13. *Trinervitermes auriterræ* Sjost. Keta, 78, causing injury to base of coconut palm.

14. *Trinervitermes ibadanicus* Sjost, Atitite, 80, from large mound termitarium on Dyson's coconut plantation.

15. *Thoracotermes macrothorax* Sjost, Aburi 89, from a small cylindrical nest, 9 inches high; 91 from nest placed on side of buttress root of a tree.

16. *Hamitermes evuncifer* Silv. var *heterocera* Silv. Aburi, 60, attacking the base of an old palm.

17. *Hamitermes evuncifer* var: *heterocera* Silv. Keta 78, causing injury to base of coconut stem, from the same source as 13. The interrelations were not determined.

18. *Hamitermes unidentatus* Wasm. Kumasi 65, in stem under bark of mango tree with *Coptotermes intermedius* Silv.

19. *Hamitermes unid-evuncifer* var. *heterocera* Silv. Kumasi 62a, from a mushroom-shaped termitarium with superimposed layers.

20. *Procubitermes aburiensis* Sjost. sp.n. Aburi 92, Nest on side of buttress root of same tree as No. 91, Soldiers very scarce.

21. *Cubitermes pallidiceps* Sjost. Kumasi, 61, mushroom-shaped nest with superimposed layers.

22. *Pericapritermes urgens* Silv. *var.* urgens Sjost. Kumasi 62a, from same nest as 18.

23. *Microcerotermes fuscotibialis* Sjost. Kumasi, 66, from a felled and rotten tree. Aburi 74, from a nest in a fork of a tree.

24. *Microcerotermes solidus Silv.* Aburi 70, from narrow runways on cacao stem. Aburi 75, attacking cacao branches through neglected wounds; Keta 77, causing injury to base of coconut stem.

25. *Ancistrotermes crucifer* Sjost. Aburi 62, ascending stems of trees, frequently spreading as a sheath round the stem and feeding on the bark, chiefly the dead material. Aburi 86—with very small fungal gardens scattered over a large area, about 18 inches below the surface. No indication above ground of presence of nest.

26. *Ancistrotermes cavithorax*, Sjost. Dsoje 83, spreading over sticks on soil.

27. *Coptotermes intermedius*, Silv. Kumasi 65, in stem under the bark of mango tree; with ground connection.

28. *Pseudocanthotermes spiniger*, Sjost. Aburi 87.

Termites attacking Cacao.

These are of two classes, those attacking directly from wounds in the stems and having no soil connections, and those attacking from narrow runways up the stems from the soil and thus entering wounds.

Of the first class, *Neotermes aburiensis*, there is no information available as to its prevalence, but it is probably fairly great owing to the lack of care to wounds. The information afforded by Prof. Ballou regarding this type may be given here :—

> " During the last few years a large termite has been attacking " cacao in Grenada, forming a nest or colony that has no con- " nection with another on the ground, or another tree, and " constructing no covered galleries in which to travel from place " to place. The insects invade the trees through wounds where " decay has started, and penetrate into healthy tissue, " often causing severe damage. Attack is *seldom serious except* " *in neglected plantations*, and the remedy lies in cleaning all " old wounds and cutting out all infested wood. All healthy " tissue thus exposed should be covered with a protective dress- " ing such as paint, tar, resin oil or Trinidad crude oil. (*Rev.* " *App. Entomology* IX. p. 516.)

Here in the Gold Coast where there is a noticeable lack of healing tissue over cacao wounds, it may frequently be seen that the wood eventually dies and decays under the coating of tar, and invasion by termites takes place, unless this material is removed. The safest procedure is to periodically retar all large wounds.

As the type of small termites attacking from the soil have no nest which can be fumigated, the best means of control is to see that all wounds are dressed, and that dead material is promptly removed.

Termites attacking Buildings.

From the control point of view these are divided also into two groups—(a) the large mound-forming and (b) those living in the soil, having no easily discovered nest, but forming small fungal gardens over a large area, with minute openings rendering fumigation almost impossible.

Control Measures.

The (a) group can be destroyed by fumigation. Through the kindness of the Chief Entomologist of the American Cyanamid Company, a quantity of calcium cyanide " Dust A ", and other calcium cyanides, together with a " Feeny " foot pump, and duster, were presented for trials.

" Dust A.", contains not less than 40%, and not more than 50% calcium cyanide and is a fine powder, about 80% passing through a 200 mesh screen.

The material was tried with nests of *T.bellicosus*. Holes were made 3 feet apart in the base of the nests, leading directly into the interior of the nest: the dust pumped in for 5 minutes at each opening. Even with openings so close together, not more than 50% of the inmates were destroyed. Using the same kind of pump, R. Owen Wahl, in Pretoria, succeeded in destroying the whole of inmates of $33\frac{1}{3}$% of the nests experimented with, but in this work a much larger quantity of the dust appears to have been used.

With a more powerful pump, a wider distribution of the gas may be affected. As the poisonous effect of the gas is transient and not " cumulative " as in the case of the sulphur-arsenic gas, the destruction of the nest must be thorough, or it may be broken up into a number of small colonies. Consequently at the present stage this method cannot be recommended.

Sulphur-arsenic, used in the proportion of one to four, yielded satisfactory results. It was found necessary to employ oil-palm nuts instead of charcoal in the furnace of the " Four Oaks " White Ant Exterminator, as the pieces of lighter charcoal clogged the discharge nozzle. The former fuel gave off more smoke, useful in locating the surface openings of the nests and indicating the area occupied by the nest; it also afforded a greater heat and thus a greater combustion of the material. The method advised of sprinkling the sulphur-arsenic over the charcoal and quickly securing the lid was found to be wasteful. With the greater heat evolved by the palm nuts, the powder can be placed in a piece of paper or dry plantain leaf. After fumigation it was found that the nests should not be opened for seven days. In some instances this proved too soon, but after ten days all the inmates were dead and the fungal gardens a mass of weeds.

For continuous working the machine is hardly adapted to the work: the defects being (*a*) small furnace, (*b*) incomplete sealing of of lid by the present method employed, (*c*) pump not powerful enough to effect a rapid and wide distribution of the gas.

Work is now in hand for the making of a larger type of Fumigator.

As fear has been expressed that there is a certain amount of risk of accidents from the employment arsenic by untrained workers, efforts are being made to find a less deadly material to handle. So far, sulphur dioxide, used successfully for rat destruction, has not given good results. The makers of the Clayton Fumigator claim a sulphur dioxide generation of an average strength of 15%, against 2-3% from the ordinary methods of producing sulphur fumes. This machine, worked with a powerful fan for distributing the gas, might be of value in this work, and it is hoped an early trial may be possible.

Whilst it has been found fairly easy to destroy the mound-forming termites, for the protection of buildings against the ravages of the small termites success can only be obtained by :—

(a) Destruction of nests in the building area before starting buildings.

(b) Employment of a good type of concrete.

(c) Employment of a course of zinc to project on both sides of the piers or the sleeper walls.

(d) To have no wood resting in a thin layer of concrete.

(e) The substitution of creosote for the solignum at present used.

(f) Impregnating wood with creosote instead of painting with tar or solignum when employed near ground level.

In spite of damage caused to buildings, in no instance has the assistance of this Department been sought when a building has become infested, but arrangements are now in hand for the work on two infested buildings to be supervised, in order to demonstrate to the workmen the care necessary to avoid reinfestation.

PAPER No. X.

LIFE HISTORY AND HABITS, ETC., OF SAHLBERGELLA SINGULARIS HAGL, AND SAHLBERGELLA THEOBROMA DIST.

By G. S. COTTERELL, A.R.C.S., D.I.C., F.E.S., *Entomologist.*

During the year a Bulletin was prepared entitled "A Preliminary Study of the Life History and Habits of *Sahlbergella singularis* Hagl., and *Sahlbergella theobroma* Dist. (Bulletin No. 3 Dept. Agric.) The following is a summary of the information given in this Bulletin.

There are two distinct species of *Sahlbergella*, the habits of which are somewhat different. Both occur throughout the cocoa belt of the Colony and Ashanti and are known in the former place as " Sankonuabe " and in the latter " Akate ". The Twi name " Sankonuabe " was given to the pests in the early days of cocoa and means " Go back to your Oil Palms ", the production of palm oil being the staple industry of the country prior to the introduction of cocoa. It indicates the importance given to the pests by the native farmer at the time when he was commencing to build up the enormous export crop we have to-day.

Both *Sahlbergella singularis* and *S. theobroma* occur throughout the cocoa-growing countries on the mainland of the West Coast of Africa, being first reported in 1902 from the Kameruns. They were first noticed in the Gold Coast in 1910 and no doubt occurred on cocoa for a long time prior to that date. They are not known in the Portuguese and Spanish Islands of San Thomé and Fernando Po, the oldest cocoa-growing countries of the West Coast of Africa.

Some doubt has been held as to whether both species are indigenous to the mainland of West Africa owing to the lack of natural controls, such as specialised parasites and predators, and the lack of alternative food plants. It was thought that possibly the insects had been imported from San Thomé or Fernando Po in the early days, without their natural enemies which, in the country of their origin, would keep them down to such an extent as to be overlooked as pests. However, certain writers who have made surveys of the insect fauna of San Thomé, particularly insects in relation to cocoa, state definitely that *Sahlbergella* spp. do not occur in S. Thomé. Recently a parasite of *S. singularis* has been bred out at Asamankese (see Paper XI of this Year book), in Akim-Abuakwa, which reaches a percentage parasitism of as much as 8%. It remains to be ascertained whether this parasite occurs in the same proportion in other parts of the cocoa-belt, and also, whether it parasitises *S. theobroma.*

Indigenous alternative food-plants are Silk-Cottons, (*Eriodendron anfractuosum* and *Bombax* sp.), on young plants and suckers of which it can occasionally be observed breeding. It is presumed that prior to the introduction of cocoa, the pests lived on Silk-Cottons and then finding cocoa favourable commenced breeding on that and increased in portion as the area under cocoa increased.

S. singularis has also been observed breeding on *Berryia ammonilla*, an imported plant. It has been stated as having been observed breeding on Cola and Cotton but experiments by the writer have failed to make it breed on these plants.

Life Histories.

The adults of both species are illustrated in Plate XI. figs 1 and 2. *S. singularis* is light brown in colour and speck bad with yellow. The antetennæ are long and the wings large, whereas *S. theosbroma* is black and stouter than *S. singularis* with shorter antennæ and smaller wings. They are more easily distinguished by the colour, size of wings, and the more prominent scutellum of *S. theobroma*.

S. singularis is considerably more active than *S. theobroma* and takes to flight much more readily when disturbed. Both species are sluggish during the day and only take to flight when disturbed. Activity is at its highest in the early morning and evening.

The habits of the two species are different. *S. theobroma* lays its eggs in first and second year wood of young trees under six years old and in the pods, and occasionally in the main trunk near a pod, on bearing trees. In the latter case, pods are only chosen that will not ripen before the resulting nymphs become full-grown. *S. singularis* on the other hand, lays its eggs in the new wood produced by the numerous new flushes of growth of the cocoa plant that occur during the year. Eggs are occasionally laid in pods but this is the exception to the rule. Just prior to and during the fruiting season a large number of nymphs of the latter species are found feeding on pods. These have come down from the newer branches to complete their life on the pods, the latter being more favourable as food. It will be understood that *S. singularis* is a more wide-spread species than *S. theobroma* as there is favourable food for it more or less the whole year round, whereas *S. theobroma* is dependent on young cocoa and developing pods. The result is *S. theobroma* is limited to those areas where there is young cocoa.

The lengths of the egg stage and nymphal instars of both species are more or less the same, the periods being somewhat longer in the case of *S. singularis* than in the case of *S. theobroma*. The average of a number of cage records is given in the table below :—

Species.	Incubation Period.	1st Instar Period.	2nd Instar Period.	3rd Instar Period.	4th Instar Period.	5th Instar Period.	Nymphal Life.	Cycle Egg to Adult.
S. singularis.	16 days	3 dys	3 dys	4 dys	5 dys	(7 dys)	23 days	38 days
S. theobroma.	14 days	3–4 days	3–4 days	4–5 days	4 dys	6 dys	21–22 days	35–36 days

The egg, illustrated in Plate XII., is embedded in the pod or branch by the ovipositor of the female, and lies at an angle of 45° with the surface. Two filaments, one shorter than the other, project from the egg and are the only visible evidence of the egg in the plant. Eggs are laid in groups averaging from 6 to 15, a lesser number being laid each time as the female becomes older.

The nymphal stages of *S. theobroma* are illustrated in Plate XII. The nymphs of each species are distinguished by the slightly darker colour of *S. theobroma* and the shape of the ultimate and penultimate points of the antennæ, those of S. *singularis* being much more elongated than *S. theobroma*. *S. theobroma* nymphs are more robust than *S. singularis* and the latter are flattened in appearance.

Feeding takes place during the early morning and evening, the nymphs of both species taking refuge under pods and in the axils of, and cracks in the branches, during the heat of the day.

An average of from five to six days elapses from time of last ecdysis from full grown nymph to adult female, before eggs are laid, this period being known as the prematurity period. A female *S. theobroma* was observed to oviposit 15 times with a maximum number of eggs of 22 at one time, and to live 27 days during which time she laid 91 eggs. Females were found to be considerably more prevalent in the field than males, although the sexes were bred out in more or less equal numbers in the cages. This is thought to be due to the shorter length of life of the male.

Symptoms of Attack.

Damage is caused by the sucking of the branches and pods and by some substance which is toxic to the plant being introduced at the time of puncturing. In the case of pods damage is localised and is not severe except for the possible secondary infection by pod diseases. Pod damage is illustrated in Plate XIII. Punctures to growing wood result almost invariable in the death of the whole branch, the poison being transmitted to the whole of the branch long after the insects have left. For this reason it is exceedingly difficult to ascertain when the bugs are on the tree. While the nymphs are completing their life-history the only sign of their presence is the wilting of one or two leaves. Two months after they have left, all the leaves have fallen from the attacked branch, and the branch has died back to the older unattacked wood without any further insect attack having taken place. When wood recovers, the scars from the injury remain throughout life as healed up ridges of bark and are usually found at the fork of branches. These are illustrated in Plate XIII.

Certain farms are known to be more or less immune from *Sahlbergella* attack, whereas other, perfectly healthy, bearing farms will suddenly be attacked after a numbers of years of immunity for no apparent reason. It is also known that farms growing in badly drained areas and sandy soil are more prone to attack although

PLATE XI.

Fig 1.—Sahlbergella singularis. Hagl.

Fig. 2.—Sahlbergella theobroma. Dist.

PLATE. XII

FIG. 1.

FIG. 1 (a)

FIG. 2.

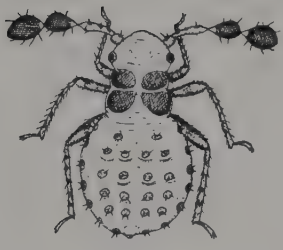


FIG. 3.

FIG. 5.

FIG. 4.

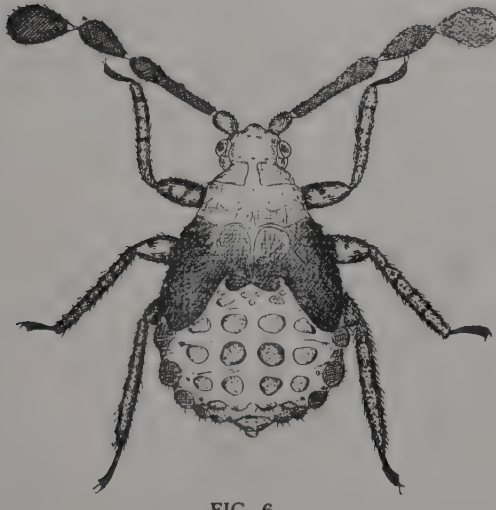


FIG. 6.

EGG AND NYMPHAL STAGES OF SAHLBERGELLA THEOBROMA.

Fig. 1.—Egg (enlarged). Fig. 1a.—Showing Egg Filaments projecting from eggs embedded in pod. Fig. 2.—First Instar Nymph. Fig. 3.—Second Instar Nymph. Fig. 4. Third Instar Nymph. Fig. 5.—Fourth Instar Nymph. Fig. 6.—Fifth Instar Nymph.

PLATE XIIa.

FIG. 1.

FIG. 2.

FIG. 3.

NYMPHAL STAGES OF SAHLBERGELLA SINGULARIS.

Fig. 1.—Third Instar Nymph.
Fig. 2.—Fourth Instar Nymph.
Fig. 3.—Fifth Instar Nymph.

PLATE XIII.

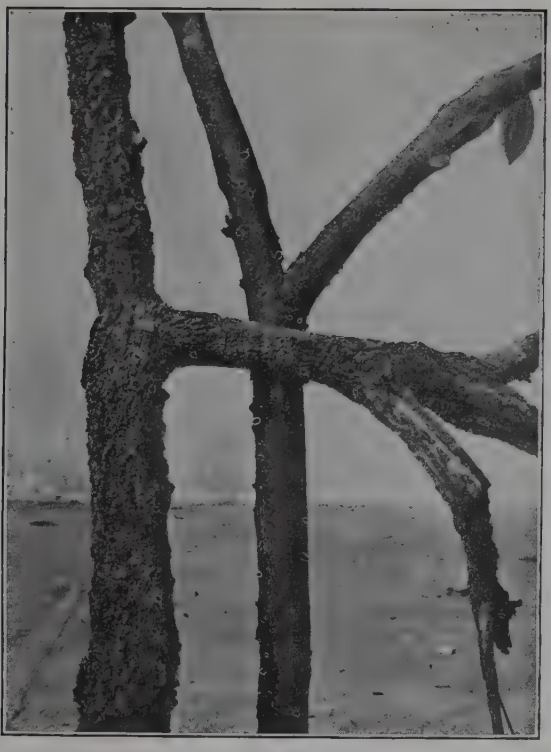


Fig. 1. Appearance of bark subsequent to Sahlbergella attack when branch was young.

Fig. 2.—Appearance of Sahlbergella damage to pods.

PLATE XIV.

Knapsack dusting machine at work on cocoa tree over fifteen feet in height.

attack is by no means confined to them. Trees growing in soils where a red loam is the predominant type are rarely attacked. It is not known whether this is due to the mechanical or chemical composition of the soil. Manuring experiments, and direct feeding experiments on the roots of cocoa trees, carried out since this paper was written, have failed to show any difference in immunity to attack. These experiments are to be repeated, however.

Methods of Control.

Natural controls of both species, as stated before, are limited. Casual predators consists of Mantid nymphs, spiders, lizards and ants, but none of these appears to be any serious check on increase. The importance of insectivorous birds has yet to be ascertained. An internal Braconid parasite, known to occur at the time Bulletin 3 was written, has been bred out in numbers, from *S. singularis* nymphs, since its publication. Details are given of this parasite in Paper XI following.

Cultural controls for the prevention of attack by *S. theobroma* on young farms consist in giving the farm the very best attention during its first six years. This will not make the farm less liable to attack but will result in less actual injury when attack does occur.

Experiments with sprays and dusts have been carried out, but it is considered that liquid spray is absolutely impractical in this country. The feeding habits of the insects being suctorial, a contact poison must be used, *i.e.*, a poison that kills the insect by actual contact and therefore necessitating the insect being covered. To insure this the whole tree must be covered and therefore an enormous amount of insecticide used on a small area. In addition to this, the average hand spraying machine, the only practical type of machine for the farms of this country, is not effective at heights. Every contact insecticide requires the making up of a stock solution requiring a certain amount of skill. Ready supplies of water are also not available on every cocoa farm.

Experiments with nicotine dusts may be practical if the native farmer will take them up. A nicotine dust consist of an exceedingly small amount of nicotine sulphate mixed with hydrated lime, the latter being used as a carrier. An ordinary efficient hand duster can be used to a height of at least 15 ft. effectively. Such a dust is illustrated at work in Plate XIV. Eight to 10 lbs. of dust are required per acre for young trees averaging 5 to 6 ft. height and about 30 lbs. for trees double this height, whereas with a liquid spray 2 gallons will only spray 20 odd trees averaging 5 to 6 ft. in height. A dusting machine will carry 20 lbs. at one charge whereas a spraying machine will only carry 2 gallons. Another advantage of a dust is that no stock solution requires to be made up on the spot.

A nicotine dust is not so efficient as a nicotine spray owing to contact not being so good. However when cost of labour is considered this easily counter-balances the slightly reduced efficiency.

Further experiments are to be carried out on the effectiveness of dusts, particularly with dusts that can be prepared locally.

PAPER No. XI.

A NEW PARASITE OF SAHLBERGELLA SINGULARIS HAGL.

By G. S. COTTERELL, A.R.C.S., D.I.C., *Entomologist*.

In Departmental Bulletin No 3, " A Preliminary Study of the Life-History and Habits of *Sahlbergella singularis* Hagl. and *Sahlbergella theobroma* Dist.," under the heading " Natural Controls ", mention is made of the lack of internal parasites and specialised predators of both species. Mention is also made of a hymenopterous parasite of *S. singularis* found by the writer at Aburi some time ago and also recently at Asamankese in Akim-Abuakwa, and this parasite had not been determined.

Of the few specimens of this parasite obtained at Aburi and Asamankese, only cocoons were obtained and difficulty was met in breeding out adult specimens. Since the completion of the work comprising the subject of this bulletin, further investigations have been made at Asamankese by Mr. E. A. A. Asare, Laboratory Attendant, whilst the writer was on leave. A number of adult specimens, both male and female, have been bred out, and some of these have been sent to the Imperial Bureau of Entomology for determination. Meanwhile it is known by its registered laboratory number 175.

This parasite belongs to the family Braconidæ and a short description is given below. A female is illustrated in Plate XV.

Length (tip of abdomen).—3 to 4 mm.
Width of body (thorax).—1 mm.
Antennæ yellow-brown in colour, long filiform.
Head and thorax black.

Abdomen black, petiolate and in the case of a female, with a protruding ovipositor.

Legs—comparatively long and yellow. Femora of middle and hind pairs of legs are dark brown to black. Tibiæ of middle and hind pairs of legs fitted with short spines at distal apex.

Wings hyaline with large stigma and lined with stout hairs on proximal half of anterior margin of fore-wings.

In the field the parasite has only been obtained from *S. singularis* and not from *S. theobroma*. Laboratory experiments are being put in hand to observe whether it will parasitise the latter species.

Neither oviposition, nor the nymphal period in which this occurs, have been observed. The latter is being ascertained.

The full-grown parasite emerges from the 4th and 5th instar (last two nymphal stages) nymphs of *S. singularis*, followed by the death of the host. Under laboratory condition pupation takes place in the soil just below the surface, but only if the surface soil is moist. It occasionally takes place on the pod or wherever the host has been feeding. In the field cocoons have been found on attacked cocoa pods, but it is thought that as a general rule the weakened host falls to the ground before emergence of the parasite with the result that pupation takes place in the soil. If the surface soil is dry at time of pupation the pupa dries up. This accounts for failure in breeding out adult specimens previously owing to the soil in the cages being too dry.

Before pupation the larva spins a tough cocoon of greyish-white silk about 3 mm. in length. After a pupal period averaging 14 days —minimum 5 days and maximum 18 days—the adult emerges by breaking through one end of the cocoon.

The following table gives percentage parasitisation from May to September, 1926, inclusive, in relation to rainfall :—

Month.	No. of *S. singularis* nymphs collected.—3rd, 4th and 5th instars.	No. of parasitic pupæ obtained.	Percentage parasitisation.	Monthly rainfall in inches.	No. of rainy days in month.
May	135	7	5.2%	5.89	14
June	97	7	7.2%	9.27	19
July	99	1	1.0%	3.40	13
August	131	0	0.0%	1.44	9
September ..	275	21	8.0%	5.88	18

Although the period over which the above records were obtained is far too short to obtain definite correlation between parasitisation and rainfall, it indicates that there may be some correlation. The percentage drops from 7 per cent in June to 0 per cent in August, the rainfall drops from 9.2 ins. to 1.4 ins. during the respective months and increases again to 8 per cent in September with increased rainfall. It is probably not rainfall that affects parasitisation, but the daily range of humidity. Unfortunately humidity records are not taken at Asamankese Station. Further work is to be done on correlation of parasitisation and humidity.

The parasite is obviously a distinct check on the rate of increase of *S. singularis*, but it cannot be said whether its efficiency can be increased until further work is done. However one factor in control is obvious, *i.e.*, retention of rain-forest. *S. singularis* is known to be more prevalent in areas where considerable deforestation has been going on and so increasing the daily range of humidity. This is partly due to the cocoa-plants becoming less healthy and therefore less resistant to insect attack but it is also no doubt partly due to a lowering of the percentage of parasitisation due to climatic conditions being unfavourable to this parasite.

Note :—This parasite has since been identified as *Euphorus Sahlbergellæ*, Wilkinson sp.n., family Braconidæ. It is hyperparasitised by the Ichneumonid *Enesochorus melanothorax*, Wilkinson sp.n.

PLATE XV.

EUPHORUS SAHLBERGELLAE Wilkinson.

A NEW PARASITE OF SAHLBERGELLA SINGULARIS HAGL.

PAPER No XII.

A NEW PARASITE OF HELIOTHRIPS RUBROCINCTA.

By G. S. COTTERELL, A.R.C.S., D.I.C., F.E.S., *Entomologist.*

During a study of the life history and habits of *Heliothrips rubrocincta,* the Cacao Thrips, at Asamankese last year a minute, internal, hymenopterous parasite, belonging to the family Chalcidæ, was found to form a considerable check during heavy infestations. At present this parasite is awaiting determination.

I have found no record of this insect occurring in San Thomé, where Thrips is a considerably more important pest than it is in the Gold Coast. It is possible that the introduction of this parasite to the former country may form a check on future infestations there.

The adult parasite, which is illustrated in Plate XVI. is 0.7 mm. in length with two pairs of hyaline wings fringed with long hair. The fore-wings have only one vein along the anterior margin. This is characteristic of the family. The thorax and head are black and the eyes dull red. The antennæ are elbowed. The abdomen is light yellow with two dark spots on the dorsal surface, and the legs are yellow.

The full-grown parasitic larva emerges from the pre-pupa of the host, *i.e.*, the penultimate stage before the host becomes adult. Actual oviposition has not been observed but adults have been noticed walking about in colonies of Thrips. Before death the parasitised host becomes sluggish and takes on a pinkish tinge. After death the body of the host becomes cylindrical and two to three days later, the parasite emerges and pupates. The pupa is black and is attached to the underside of the leaf at its hinder end by the dried skin of the host. The pupa lies at an angle of approximately 30° with the surface of the leaf. After eleven days as a pupa the adult parasite emerges.

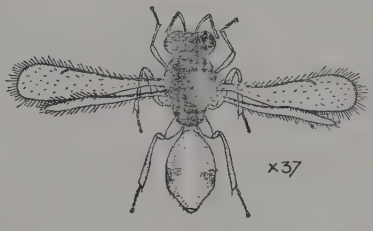
Parasitism reaches its highest percentage during heavy infestations of Thrips and drops to a negligible quantity when Thrips are comparatively scarce. In a small Thrips infestation, where the colonies are small and scattered, parasitisation does not reach a high figure but in heavy infestations whole colonies on one leaf consisting of fifty or sixty individuals are commonly found completely parasitised. The heaviest infestations of Thrips occur during and after periods of low rainfall. These infestations are gradually brought down to normal by the proportionate increase of the parasite. The parasite, therefore, is most common in September following the decreased

rainfall in August, and also during the main dry season in January and February, reaching a percentage parasitisation of as much as 30% to 40%. Normally it drops to negligible numbers from April to the end of July. In 1925, when the rainfall in the earlier months of the year was abnormal, and the rainfall in June considerably above the average, there occurred a heavy Thrips infestation with a consequent proportionately heavy parasitisation which reached a maximum of between 70% to 80%.

It is probably solely because of this parasite that *Heliothrips rubrocincta* has not become such an important pest in this country as it has done in San Thomé.

PLATE XVI.

A NEW PARASITE OF HELIOTHRIPS RUBROCINCTA.



PAPER No. XIII.

EFWATAKALA GRASS (MELINIS MINUTIFLORA). TRIALS AT KUMASI AGRICULTURAL STATION

By T. HUNTER,

Superintendent, Kumasi Training Centre.

An account of this grass was given in the " Bulletin of The Imperial Institute " Vol. 20, page 300, 1922, as a result of observations made by Mr. M. T. Dawe, when on tour in Angola, pointing out that trials should be made in various parts of Africa with a view to testing its value, both as to its reputed insect-repelling properties, and as a useful fodder grass.

Seed of this grass was received from Kew in June, 1923, and during 1924 the grass was planted over an area of 2 acres, on rising ground leading up from the swamp to the Training Centre. This area was quickly established.

Trials as a Mosquito-Repeller.

In consultation with the Medical Officer of Health, artificial breeding sites were created in and around this area, to obtain information with regard to its use as a mosquito barrier.

The breeding sites were constructed by cutting down cement barrels and placing them in the soil, both within and outside the grass-planted areas, afterwards filling them with water. Artificial shade was provided with palm leaves, and access to the barrels was debarred to frogs, lizards, etc., by covering the mouth of each barrel with small-mesh netting.

Observations made during 1924-5 seemed to indicate that mosquitoes avoided this grass, as only on one occasion were mosquito larvæ found in one of the tubs inside the grass, whereas, in the tubs outside the grass and near the swamp, larvæ were frequently observed.

Further observations were again made during 1926. This year's results prove that the grass had no effect in preventing the breeding of mosquitoes. During June, July, and August, all the tubs contained numerous larvæ. The tubs were emptied at the end of each month, and refilled with fresh water.

Some of these breeding sites were so unnatural, that the evidence conclusively proves the grass to be of little use as a mosquito barrier.

The Senior Sanitary Officer, Dr. P. S. Selwyn-Clarke, who has kindly co-operated in these experiments, entirely agrees with the conclusions drawn, with regard to the absence of barrier qualities in the grass in question

He explains that the absence of breeding last year, may possibly be accounted for by the fact that the collections of water were too recent as far as anopheline mosquitoes were concerned. While so many natural pools were available in the immediate vicinity, it was unlikely that an anopheline would choose an artificial pool.

This year a number of the artificial pools had become much more "natural" as the result of the growth of algæ and other vegetable matter; moreover owing to more effective draining in the swamp area, the number of available breeding places was greatly reduced, so much so, as to render the anopheline mosquito much more dependent upon less natural areas.

The absence of Stegomyia mosquitoes may be accounted for by the relatively small number in the area, and the predilection this type always has for domestic supplies of water *e.g.*, breeding-places closely associated with dwelling-houses, cowsheds, etc.

Only in one instance was Stegomyia found, and that was in the tub nearest to dwelling-houses.

The effect of the grass on tsetse flies could not be tested as no facilities for doing this are available in the vicinity of Kumasi. This would have to be tried in the cattle-breeding area.

Value as Fodder.

The grass appears to have had no ill effect on fruit trees around which it was planted. It is easily eradicated when desired, and from observations made has no toxic effect on the soil; corn and other crops have been grown successfully where the grass was previously growing for two years.

This grass which is easily raised from seed, and readily spreads by runners, was found to compete successfully with other weeds. It is an excellent cover-plant for preventing soil wash, and has also provided large quantities of useful material for mulching purposes.

The yield obtained was approximately 5 tons per acre dry weight.

Its use as a fodder grass was tested by feeding it to cattle arriving in Kumasi from the Northern Territories while awaiting removal to markets.

The grass was fed daily to different cattle each day in both a fresh and dry state, and observations were made over a period of 10 days. The cattle fed on it readily, but showed a distinct preference for the freshly cut grass.

Horses also fed on it readily, both in the stable, and in the field, so that its use as a fodder grass is promising, and it is worthy of extension for this purpose.

PAPER No. XIV.

REPORT ON THE ACCRA SISAL PLANTATION.

By J. M. WINGATE,
Acting Superintendent.

As this plantation has been established nearly six years, it is now possible to give reliable figures shewing output, cost, yields etc., and the results of the several experiments made.

The adjoining tables shew production and cost for the period 1st April 1925 to 30th September, 1926.

It will be seen from the adjoining table that only three cuttings have been made and as five or six are anticipated a fair estimate of the total yield per acre would be 26 cwts.

PERCENTAGE OF FIBRE IN LEAF.—After several experiments the average percentage of fibre in the leaf was found to be 3.46. This compares very favourably with the percentage obtained in samples grown in other sisal hemp producing countries.

PESTS AND DISEASES.—Very small areas on the plantation were affected by sisal anthracnose (*Colletotrichum agave*) in 1924, but after all diseased plants had been destroyed the trouble disappeared and has not been observed since.

In the same year sun scorch was responsible for the destruction of a considerable quantity of leaf. Specimens of the attacked leaves were sent to the Mycologist, Aburi, who reported as follows :—

" On many of the leaves reddened patches occur which, accord-
" ing to Dowson, who observed the same trouble in Kenya, are
" caused by Sun Scorch in a very wet rainy season. I enclose an
" extract from his paper. "

Dowson (W.J.) :—Some problems of Economic Biology in East Africa.

" (Kenya Colony). . . . . Sisal Hemp (*Agave rigida, var*
" *sisalana*) is also grown in the coastal belt. It has few
" enemies. Ring-spot disease, caused by *Colletotrichum agave*
" Cav. has been recorded in a very wet rainy season. The
" spores of this fungus can be disseminated by air-currents. In
" similar conditions a Sun Scorch nearly always takes place,
" causing large, reddened patches which render decortication
" difficult or impossible. In the season when Ring-spot disease
" occurred a yellow bacterial blotch was found near Nairobi and
" by the amount of gum produced on the tissues, decortication
" was rendered impossible. Sunken yellow areas were pro-
" duced on the upper half of the leaves, varying in size from a

ACCRA SISAL PLANTATION AND FACTORY.

SUMMARY OF PRODUCTION AND COST FOR THE PERIOD 1ST APRIL, 1926 TO 30TH SEPTEMBER, 1926.

Month. 1926	Number of days worked.	Acres Reaped.	Cwts. of Fibre Produced.	Expenditure. £ s. d.
April, ...	21	*A. — *B. 155.40 *C. —	800	706 8 11
May, ...	21	A. 53.00 B. 47.00 C. —	760	702 2 2
June, ...	23	A. 66.00 B. 40.50 C. —	780	674 9 10
July, ...	24	A. 35.00 B. 106.00 C. —	800	759 8 6
August, ...	23	A. 7.40 B. 91.00 C. 64.20	660	718 16 11
September, ..	23	A. — B. — C. 188	820	653 8 10
Totals ..	135	A. 161.40 B. 439.90 C. 252.20 853.50	4,620	4,214 15 2

Spares and eplacements (not charged to any one month) ..	50 19 2
	£4,265 14 4

	Days Worked.	*Acres Reaped.*	*Cwts. of fibre produced.*	*Cost.*
Monthly Average	22.5	142.25	770	£710 19 1

Average output of fibre per working days (of nine hours) ..	34.22 cwts.
Average yield (fibre all grades) per acre A. 1st Cutting ..	9.50 ,,
B. 2nd	4.75 ,,
C. 3rd	3.10 ,,
Factory and Plantation Costs of producing one ton of fibre ..	£18 9 3

*A, B and C represent first, second and third cuttings respectively.

ACCRA SISAL PLANTATION AND FACTORY.

SUMMARY OF PRODUCTION AND COST FOR THE PERIOD 1ST APRIL, 1925 TO 31ST MARCH, 1926.

Month.	Number of days worked.	Acres Reaped.	Cwts. of Fibre Produced. Grade I.	Grade II.	Tow.	Expenditure. £	s.	d.
April, 1925 ..	16	*A. 26.90 *B. —	268	14	38	402	7	0
May, ...	25	A. 22.48 B. 35.00	399	62	39	588	17	7
June, ...	11	A. — B. 36.00	136	18	26	633	9	5
July, ...	24	A. 24.00 B. 48.00	376	80	64	620	3	11
August, ...	20	A. 17.00 B. 25.50	447	40	13	647	14	9
September, ..	2	A. 4.50 B. —	50	—	—	516	8	10
October, ..	0	0	0	0	0	550	1	2
November, ..	13	A. 34.00	352	40	8	640	5	9
December, ..	25	A. 56.00 B. —	727	55	23	772	10	8
January, 1926 ..	24	A. 66.00 B. —	735	50	25	738	10	0
February, ..	21	A. 71.50 B. —	647	55	18	679	3	0
March, ...	24	A. — B. 187.50	808	66	26	759	11	1
Totals	205	A. 322.38	4,945	480	280			
		B. 332.00		5,705				
		654.38				7,549	3	2
Spares and Replacements (not charged to any one month) ..						420	4	8
						£7,969	7	10

	Days Worked.	*Acres Reaped.*	*Cwts. of Fibre produced*	*Cost.*
Monthly Average	17	54.53	475.4	£664 2 4

Average yield (fibre all grades) per acre A. 1st Cutting 12.4 cwts.
B. 2nd ,, 6.9 ,,
Average output of fibre per working days (of nine hours) .. .. .. 27.8 ,,
Factory and Plantation Costs of producing one ton fibre .. £27 18 9

*A, B represent first and second cuttings respectively.

" small speck to a patch several inches in length. Spread
" ceased at the end of the rains. The organism—a bacillus—
" was isolated and produced the disease by inoculation. It
" has not been studied in detail."

The disease on this plantation also occurred after very heavy rains and as was the case in Kenya, spread ceased at the beginning of the dry season.

LABOUR.—Considerable difficulty has been experienced in obtaining a sufficiency of labour for outside work, but on the other hand this difficulty was not found in getting inside labour for factory work.

Labourers are recruited from the Northern Territories and the average supply from this source is 80 per annum.

It was found necessary to increase the rate of pay from 1/6 to 2/- per day in order to attract local labour, and a bonus for good work and regular attendance was also paid at the rate of 5/- and 2/6 per month according to standard of work.

Local labour will always be scarce during the cocoa season and when large building works are being laid down in the Accra district.

EXPERIMENTS.—In the early stage of the plantation the young sisal was intercropped with cassava, but owing to the amount of weeding required for this crop it was found to be uneconomical and was discontinued. It was also observed that the areas intercropped with cassava yielded considerably less than areas where no intercropping took place.

The original 1,000 acres received very careful weeding and consequently the expenditure for this item was exceedingly high, reaching a total of £5 per acre for the first 3 years.

An experimental plot of 40 acres was planted in May, 1925, with the object of finding out whether clean-weeding was absolutely necessary in the growing of sisal. This plot is to receive only 3 weedings during its life (every 6 months for the first eighteen months). If this method is found to be an efficient one the cost of weeding will be reduced from £5 to £2 per acre.

Up to the present this plot has received two weedings in 17 months, and all the plants are healthy and as advanced as areas which have received more frequent weedings.

TASKS.—The following are the daily tasks for the different work on the plantation.

*Planting..	250 plants per man.
Heavy weeding..	150 plants per man.
Light weeding	250 plants per man.
†1st cutting	65 plants per man.
†*2nd cutting	120 plants per man.
†3rd cutting	175 plants per man.

*Includes the gathering of suckers.

†Includes carrying cropped leaves to the light railway line not more than 175 plants distant.

PRICES REALIZED.—The prices realized in England for the different grades were as under :—

Grade I. £39 to £43 10s. per ton.
Grade II. £36 to £40 per ton.
Tow £25 to £30 5s. per ton.

In conclusion, it may be stated the Government's main object in starting the Accra Sisal Plantation was to try and create a new industry for the people of the Accra plains.

It has been proved that the land in this district, though of little value for the production of food crops, is admirably suited for the cultivation of sisal hemp.

Considering this land has never been cultivated to any great extent and consequently has been of no great value to the African owners, it would seem strange if the Accra people did not make a start now with the growing of sisal and thereby create an industry which is certain to prove a very lucrative one for both farmer and trader.

PAPER No. XV.

YIELDS OF COLA AT KUMASI AGRICULTURAL STATION.

By T. HUNTER,
Superintendent, Kumasi Training Centre.

During 1911 and 1912, 14 acres of forest land were cleared and planted with cola, 25′ x 25′ apart. This area was kept under clean cultivation during the first four years, but the results were not very satisfactory as in 1915 only one-third of the trees were established.

2. A good temporary shade of plantains was then planted and the natural undergrowth allowed to grow between the lines. This treatment proved effective, the plot being completely established during that year. The clearing of the lines and necessary attention to young trees were all that was done until 1921, when the area was gradually cleared, as the trees developed and fruiting increased.

3. Experience on this, and other stations, has proved that growth is slow and disappointing during the early years, unless the young plants are well shaded until they attain a height of 10′. The best results have been obtained where plantations have been formed by planting in lines in the forest, cutting the latter away as the trees developed.

4. The variety grown is *Cola acuminata,* which presumably is synonymous with the *Cola nitida* referred to in various parts of the East.

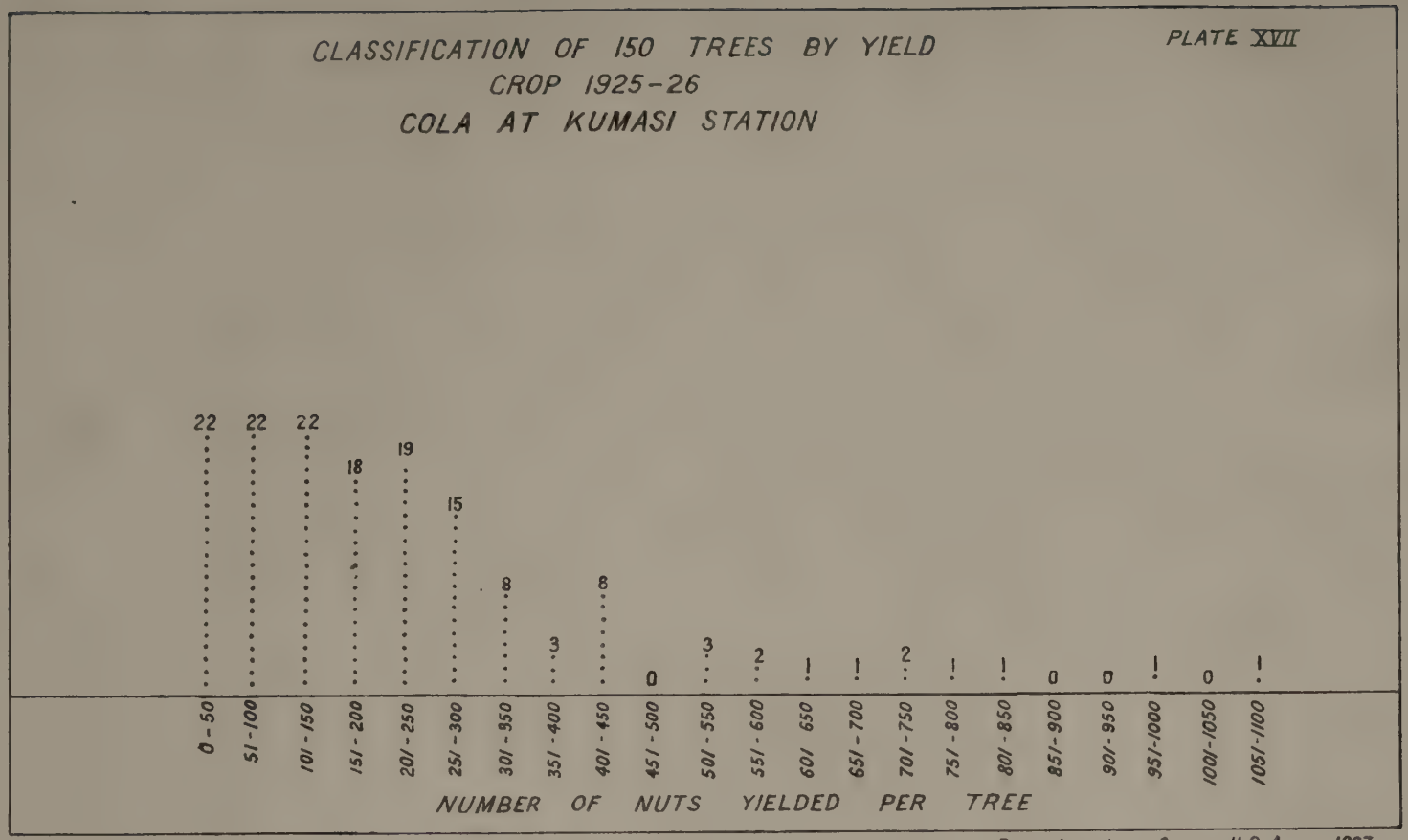
5. During 1923 the area was squared off and the plot reduced to 10 acres.

6. The earlier planted trees began to fruit in 1916, when 19 trees fruited for the first time the number of fruiting trees increasing annually until 1922, when the whole area had reached the fruiting stage.

The cola weevil *Belanogastris colæ,* which is usually so troublesome in destroying a large number of nuts, did not give much trouble until 1924, but this pest is evidently now on the increase, and in 1925-26 destroyed 68% of the crop.

PLATE XVII

CLASSIFICATION OF 150 TREES BY YIELD
CROP 1925-26
COLA AT KUMASI STATION



Reproduced at Survey H.Q. Accra, 1927.

During the last 7 years, records have been kept of the individual yields obtained from 150 trees, and this record is attached. These trees were not selected but were in one block.

RECORDS OF YIELDS SINCE 1916.

Year.	Area.	No. of trees fruiting.	No. of Nuts reaped.		Total.
			Good nuts.	Bad nuts.	
1916	14 acres.	19 trees.	70	Not recorded.	70
1917	,,	22 ,,	142	do.	142
1918	,,	40 ,,	4,011	do.	4,011
1919	,,	41 ,,	4,500	do.	4,500
1920	,,	126 ,,	4,900	do.	4,900
1921	,,	128 ,,	5,210	do.	5,210
1922	,,	Whole plot fruiting.	17,137	do.	17,137
1923	Reducedto10 acres.	,,	99,961	do.	99,961
1924	,,	,,	84,008	45,000	129,008
1925	,,	,,	41,504	90,603	132,107

In order to summarise the figures in the foregoing Tables, the spotgraph in Plate XVII. has been prepared. The figures used are those for 1925/26, since between the year 1923 and 1924-5 the reaping season was altered and the figures ceased to be returned for the calendar year. Previous to 1923, the trees were not in full bearing.

Inspection of the graph shews that most of these trees yield from 0 to 300 nuts per annum, these classes accounting for 118 out of 150 trees.

INDIVIDUAL YIELDS OF COLA TREES.

KUMASI EXPERIMENT STATION 1919–1926.

Tree No.	Number of nuts (including diseased) per tree.						
	1919	1920	1921	1922	1923	1924-25	1925-26
1	—	—	20	—	54	18	135
2	—	—	—	—	—	1	19
3	—	—	—	—	—	6	51
4	—	26	19	—	847	18	109
5	—	—	—	652	162	1,358	576
6	—	—	—	576	160	576	172
7	—	—	—	—	—	10	101
8	—	—	—	4	79	304	102
9	—	—	—	—	—	—	58
10	—	—	—	—	—	12	52
11	—	—	8	—	696	46	139
12	—	—	—	—	—	—	—
13	—	—	10	293	26	105	311
14	—	—	12	122	349	182	269
15	—	—	—	—	—	113	240
16	—	—	—	11	15	230	76
17	—	—	—	62	—	—	—
18	—	—	—	—	485	189	55
19	—	—	—	140	170	16	146
20	—	—	—	—	144	—	129
21	—	—	—	17	30	24	130
22	—	—	15	260	328	5	84
23	97	—	25	—	42	757	98
24	—	25	12	112	367	164	100
25	—	—	—	—	—	13	3
26	—	—	—	—	—	3	278
27	—	—	—	—	—	—	144

Tree No.	Number of nuts (including diseased) per tree.						
	1919	1920	1921	1922	1923	1924-25	1925-26
28	—	—	—	—	—	—	248
29	—	23	28	254	280	47	276
30	—	—	—	43	—	209	518
31	—	—	—	376	169	317	203
32	—	50	20	54	236	76	114
33	—	41	38	60	1,937	370	358
34	—	—	—	104	260	70	153
35	—	—	—	8	73	270	111
36	—	—	—	—	—	146	228
37	—	11	27	200	111	354	334
38	—	50	24	314	134	468	403
39	—	—	—	506	45	1,098	162
40	—	6	20	62	103	308	213
41	—	—	—	—	—	965	268
42	—	—	—	—	157	279	248
43	—	—	—	710	85	585	185
44	—	—	—	—	—	243	129
45	—	—	—	243	—	269	224
46	—	—	13	1,890	695	1,063	253
47	—	—	18	92	22	948	172
48	89	—	76	—	71	492	87
49	—	—	—	—	—	—	50
50	80	—	106	—	—	—	40
51	—	—	—	—	—	6	54
52	—	4	58	38	—	43	409
53	—	—	—	12	212	1,631	619
54	—	—	—	162	781	212	147

INDIVIDUAL YIELDS OF COLA TREES.—*continued.*

KUMASI EXPERIMENT STATION 1919–1926.

Tree No.	Number of nuts (including diseased) per tree.							Tree No.	Number of nuts (including diseased) per tree.						
	1919	1920	1921	1922	1923	1924-25	1925-26		1919	1920	1921	1922	1923	1924-25	1925-26
55	—	—	—	127	88	82	125	82	—	—	—	143	68	208	112
56	—	—	—	141	103	666	412	83	—	—	—	—	—	101	126
57	—	—	—	—	188	703	165	84	—	—	—	—	75	569	69
58	—	—	—	45	—	535	297	85	—	42	57	—	181	46	54
59	—	—	—	—	—	37	57	86	—	—	—	—	167	81	93
60	—	—	—	—	53	56	95	87	—	—	42	—	330	881	53
61	—	—	—	—	—	931	171	88	—	58	100	—	560	2,637	81
62	—	—	—	—	—	619	70	89	—	—	—	—	—	149	151
63	—	—	15	—	124	2,348	180	90	—	—	—	—	906	171	318
64	—	—	—	30	112	85	137	91	—	—	—	508	554	501	261
65	120	50	85	122	1,426	586	151	92	—	—	—	316	891	259	433
66	—	—	—	—	171	210	265	93	—	—	—	396	777	313	418
67	—	—	—	725	128	2,382	664	94	—	—	—	68	—	178	229
68	—	—	4	—	185	248	106	95	—	—	—	—	—	703	264
69	—	—	—	74	—	1,847	256	96	—	—	—	—	240	134	163
70	—	—	—	8	—	—	18	97	—	—	—	—	698	56	60
71	—	4	34	—	—	16	2	98	—	—	—	—	—	259	310
72	—	—	—	31	51	28	25	99	—	—	—	1	—	103	106
73	—	—	—	—	—	—	14	100	—	—	—	—	—	245	741
74	—	—	—	201	—	57	—	101	—	—	—	—	297	617	379
75	—	—	—	—	—	6	46	102	157	21	104	—	47	221	199
76	—	—	—	—	59	3	107	103	—	—	—	214	123	302	168
77	—	—	—	—	43	236	230	104	—	—	25	348	980	1,560	208
78	—	—	—	—	—	15	9	105	—	—	—	—	47	632	212
79	—	—	—	—	277	70	20	106	—	—	28	532	44	769	434
80	—	—	8	—	—	143	65	107	100	71	94	461	—	861	279
81	—	—	—	76	119	458	47	108	—	—	—	376	—	543	168

INDIVIDUAL YIELDS OF COLA TREES.—*continued.*

KUMASI EXPERIMENT STATION 1919–1926.

Tree No.	Number of nuts (including diseased) per tree.						
	1919	1920	1921	1922	1923	1924-25.	1925-26.
109	—	—	—	—	46	793	301
110	—	—	—	—	101	661	168
111	—	—	—	6	314	653	301
12	—	—	—	—	431	222	245
113	—	—	—	—	486	275	218
114	—	—	—	—	—	57	212
115	—	—	—	—	—	112	254
116	—	—	—	—	—	254	232
117	—	16	49	—	2,167	18	215
118	—	—	—	—	434	114	250
119	—	—	—	21	472	71	189
120	—	—	—	644	488	520	558
121	75	—	18	624	274	2,490	286
122	100	241	125	—	—	—	429
123	—	—	—	—	—	36	276
124	—	—	—	—	—	263	208
125	—	—	—	—	—	—	317
126	—	—	—	262	—	216	45
127	—	—	—	—	—	606	267
128	—	—	—	—	—	—	6
129	—	—	—	7	—	—	33
130	—	—	—	—	68	—	84
131	—	—	—	—	—	—	4
132	—	—	—	—	321	—	120
133	—	—	2	523	217	50	21
134	—	—	—	—	—	25	30
135	—	—	—	—	—	—	59
136	—	—	—	—	—	6	131
137	—	—	—	177	1,106	205	192
138	—	—	—	—	27	44	173
139	—	—	—	—	22	261	801
140	—	—	—	—	—	4	799
141	—	—	—	580	—	42	307
142	—	—	—	1,029	649	425	243
143	—	—	—	178	58	19	967
144	—	—	—	—	—	219	417
145	—	—	—	188	22	515	360
146	—	—	—	365	316	536	739
147	—	—	—	—	—	457	507
148	—	—	—	40	117	207	26
149	—	—	—	63	231	260	1,093
150	—	—	—	—	—	56	535
Means	5	5	9	113	186	331	207

PAPER No. XVI.

RESULTS OF TRIALS WITH LIMES (CITRUS MEDICA VAR. ACIDA) IN THE CENTRAL PROVINCE.

By J.STEELE, M.C., N.D.A., N.D.D.,
Acting Provincial Superintendent of Agriculture, Central Province.

Limes are to be found in small quantities growing over the whole of the Central Province and single trees are comparatively common in most compounds. A lime plot at Asuansi Experiment Station about 3 acres in extent was planted in 1912 ; the seed apparently came from Aburi from the large fruited or "sweet" lime. Further supplies of lime seeds were obtained from the Agricultural Station at Aburi in 1914-15-16, and were utilised to extend the plot at Asuansi to 13 acres. The limes used to plant this area were of the spiny type.

No serious attempt at establishing lime plantations in the Gold Coast were made until the early part of 1925, when it was decided to induce farmers to plant at least 300 acres in the vicinity of Abakrampa in the Central Province, about 15 miles from the coast-line. The land around Abrakrampa had almost been denuded of forest trees, with the result that cacao planted in this area either died or was abandoned.

It was decided that seed should be sown at stake 12 feet apart. Early in May was considered the best time for sowing, the sowing to be done on two successive days. The Omanhene and farmers in the Abakrampa district were called together and it was explained that 300 acres of land within 4 miles of Abakrampa were required on which to plant limes.

It was explained that the limes should be planted at stake 12 feet apart, that the seed would be supplied free from Asuansi Experiment Station, and that the most suitable farms on which to plant limes were those that had just been planted with corn or yams. It was explained that the limes would be planted in a similar manner to that adopted for cacao by farmers, with the exception that lining should be more carefully carried out. The farmers were asked to prepare stakes about 3 feet in length and 1 inch in diameter, 300 stakes being needed for each acre of cultivation. An Overseer with the aid of a few headmen and local Cacao Instructors went round and lined off each farm ; this work was begun in the middle of April, 1925.

In the beginning, the majority of farms dealt with varied in size from $\frac{1}{2}$ an acre to 3 acres in extent and these were scattered over a fairly large area with the result that supervision was difficult. As the farms were lined off a list of farms was made, each farm being given a number, the name of the farmer entered, the number of stakes put in and the position of each farm noted in order that they could be located in the bush. In the early part of May, 1925, sufficient lime seeds were collected from the Experiment Stations in the Colony and the work of planting was commenced; at the end of May approximately 400 acres had been planted, on an average four seed being planted at each stake.

In some cases farmers had a small quantity of seed left; this they were told to sow in a nursery near their farms, in a similar way to that adopted in making cacao nuseries, so that from such nurseries they would have a supply of young seedlings to fill up vacancies.

Germination Tests.

At a discussion held in Accra regarding the planting of limes by farmers at Abakrampa, the question of planting lime seeds at stake, as compared with planting seedlings from a nursery, was discussed. It was the general opinion that lime seeds, like other citrus seeds, quickly lose their vitality and germinative power. In order to obtain information on this point, the following tests were carried out. 2,000 seeds were used during the test; these were prepared by drying in the sun for four days, the pulp removed from the seed-coat by rubbing with charcoal and the seed stored in a tin box with sufficient airholes for ventilation.

100 of these were sown every third day until the supply was exhausted. Results are given in the adjoining Table 1.

It is clear that after 24 days, the loss of germinative-power becomes very rapid, and that half the seeds are valueless after 36 days.

Land on which the Limes were Grown.

The soil on which the limes are grown at Asuansi and Abakrampa varies considerably, from a very light sandy soil in parts to a comparatively heavy reddish clay soil. The land is generally undulating in nature and it has been found that limes grown on swampy and badly drained land do not make much progress. The elevation above sea-level of the land at Asuansi and Abakrampa is approximately 200 feet; the undulating nature of the land is a source of protection against drying winds during the dry season.

The plantation at Asuansi Experiment Station has been laid out at 18 feet apart; seedlings were planted, holes 18 inches cubed having been previously dug for the reception of the young seedlings. Limes planted in 1916 at Asuansi were interplanted with plantains to provide shade for the young lime trees, but in the year 1921 the growth of many of the trees had been retarded owing to the fact that the plantains had overgrown the young limes.

TABLE I.

GERMINATION TEST ON LIME SEEDS AT ASUANTSI.

Successive periods of three days each.	Date Sown.	Date of Germination.	Percentage of seed Germinating.
1st	4–9–25	20–9–25	92%
2nd	7–9–25	23–9–25	74%
3rd	10–9–25	26–9–25	86%
4th	13–9–25	29–9–25	87%
5th	16–9–25	2–10–25	90%
6th	19–9–25	6–10–25	96%
7th	22–9–25	9–10–25	88%
8th	25–9–25	12–10–25	88%
9th	28–9–25	15–10–25	71%
10th	1–10–25	19–10–25	91%
11th	4–10–25	22–10–25	71%
12th	7–10–25	26–10–25	82%
13th	10–10–25	29–10–25	60%
14th	13–10–25	31–10–25	37%
15th	16–10–25	4–11–25	56%
16th	19–10–25	6–11–25	48%
17th	22–10–25	9–11–25	53%
18th	25–10–25	12–11–25	60%
19th	28–10–25	15–11–25	52%
20th	31–10–25	20–11–25	27%

The mean percentage of germination for successive period of 12 days was therefore :—

During 1st	12 days	84.7	per	cent.
2nd	12 "	90.5	"	"
3rd	12 "	78.7	"	"
4th	12 "	50.2	"	"
5th	12 "	48.0	"	"

At Abakrampa over 620 acres of limes have been planted by farmers, seed being sown at stake. In farms where seed was sown at stake in May, 1925, the young limes have by December, 1926, reached a height of between 3 and 4 feet and there are very few vacancies. The plants are a nice green colour and are vigorous in growth. The average height of the young limes over the 620 acres is probably about 2 feet 6 inches.

The best results have been obtained where farms have been interplanted with yams and cassava ; these have been cultivated and incidentally the young limes have benefited by the cultivation. Weeds and rubbish collected during the process of hoeing are placed around the young limes in a circle about 8 feet in diameter, the

farmers having been asked to do this on the approach of the dry season, and in this way moisture has been retained in the soil for the use of the young plants during the drought which lasts as a general rule from the middle of December until the middle of March.

It is important that lime plantations should not be exposed to strong winds, hence farmers have been requested to retain a portion of bush on the windward side of the plantation as a protection. The height of the bush in the Abakrampa district varies from 6 feet to 30 feet, with occasional forest trees and oil palms.

Nursery-Beds.

At Asuansi Experiment Station, where a considerable stock of lime seedlings is usually kept, the nursery soil is of a light sandy nature, and beds are made 4 feet wide, slightly raised to provide drainage. The seed is sown approximately $\frac{1}{2}$ inch apart, in shallow drills, each drill being 1 foot apart. The seeds are protected from the sun by means of a light shade of oil-palm leaves, the seed-beds being kept regularly watered during the dry season. If the seed-beds are made in May or June, little or no watering is required and the young seedlings are ready to plant out about 14 months later. The seed is collected from large fruits and from good bearing trees, and washed with water to rid them of the mucilaginous matter, and charcoal is placed amongst the seeds to dry them : in this way the seed retains its vitality much better during storage and is much more easily handled during planting.

The root system of the young limes is improved if the young seedlings are lifted from the seed-bed and transplanted about 4 inches apart in drills 15 inches apart. At Asuansi the limes are planted 18 feet apart while the limes at Abakrampa have been planted 12 feet. If the limes are too closely planted the branches become intermingled and in a very short time begin to atrophy ; these should be removed in order to facilitate the harvesting of the fruit from under the trees. Where the limes have been planted 12 feet apart and it has been found to be too close, in really good heavy soils it will be an easy matter to remove alternate trees.

Yields.

The limes at Asuansi began to bear four years after planting. Those planted in 1916 began to bear in 1920, but profitable yields were not obtained until 1923.

Since 1921 the lime plot at Asuansi has received an annual hoeing, usually at the end of the year just prior to the dry season. During the wet season the whole plot is simply cutlassed. When the trees are fully established and cover the whole of the ground there is very little undergrowth. But the expense of removal of the dead lower branches, equals if not exceeds the cost of cutlassing the bush previously.

Bengal beans (*Mucuna*) have been grown successfully between young lime seedlings at Asuansi. These, being a leguminous crop, increase the nitrogen content of the soil ; they grow luxuriantly

and provide an abundance of green material for mulching the young limes, but care should be taken that the beans do not cover the young seedlings.

The lime plantation at Asuansi produces fruit throughout the whole year. But the maximum amount of fruit is usually produced during the months of August and September. The following Table II. shows the monthly yields of fruits from a row of five trees for the years 1922, 1923, 1924 and 1925.

TABLE II.

FIVE TREES—NUMBER OF FRUITS.

Month.	1922.	1923.	1924.	1925.
January	16	40	64	132
February	40	220	102	615
March	424	1,332	1,265	1,212
April	563	1,805	2,569	3,568
May	250	905	169	1,320
June	628	175	780	670
July	810	214	2,690	2,544
August	4,090	3,739	1,900	7,864
September	8,256	5,500	1,706	7,653
October	2,901	1,942	1,400	1,018
November ..	450	110	180	650
December	54	72	87	246
Total	18,482	16,054	12,912	27,492
Per Tree	3,696	3,211	2,582	5,498

The following Table III. shows the yield of fruit in lbs. from a plot of one acre in area for the year 1926, the trees being ten years of age.

TABLE III.

Month.	Pounds of fruit per acre.
January 1926 ..	236 lbs.
February	391 ,,
March	1,330 ,,
April	1,515 ,,
May	2,338 ,,
June	2,463 ,,
July	2,258 ,,
August	3,296 ,,
September ..	3,353 ,,
October	3,898 ,,
November ..	3,449 ,,
December ..	3,464 ,,
Total	27,991 lbs. or 174 barrels of 160 pounds each.

Six samples of lime-juice from these and other local trees were examined by the Chemist during the year. They contained an average of 13.3 ozs. of citric acid per gallon, with extremes of 12.2 ozs. to 14.4 oz. This figure is slightly higher than West Indian figures.

The yield from good plantations in the West Indies is about 150 barrels of fruit per acre, the average being somewhat lower or about 100 to 120 barrels.

Preparation of Concentrated Juice.

A test was carried out at Asuansi Experiment Station in 1924. The fruits were collected from the plantation and placed in cement barrels. Ten barrels of limes were taken, each barrel weighing 150 lbs. Each barrel of fruit produced 5 gallons of raw juice, so that from ten barrels 50 gallons were produced. The raw juice was placed in iron pots and boiled down to one-tenth of its original volume, or 5 gallons.

The costs of gathering and pressing ten barrels of fruit and concentrating the juice obtained is shown below.

Gathering	3/4d.
Pressing	3/9d.
Gathering firewood and firing	3/-.
	10/1d.

Therefore the cost of production of 31 gallons of concentrated juice on the Station would be £3 2s. 10d. The raw lime juice after pressing was strained through a rubber-latex strainer to remove seeds and pulp.

The iron boilers used for concentrating the juice were corroded by the action of the juice during concentration and this had the effect of reducing the acid content.

A cask containing 31 gallons of concentrated juice was shipped to England and the return was as follows :—

1 Cask—31 galls : of 80.50 ozs citric acid per gallon at £20 per 108 galls. of 64 ozs.—£7 4s. 5d.

	Discount 2½%		£0 3 7
			£7 0 10
Analysis	.. £0 7 0		
Fire Insurance ..	.. 0 0 3		
Brokerage	.. 0 1 5		
Freight..	.. £1 6 4		
Marine Dues	.. 0 1 3		
Handling charges ..	.. 0 19 9		
London Charges ..	.. 0 1 8		£2 17 8
	Net Proceeds		£4 3 2

Fresh Limes.

Fresh limes have been exported to England on a small scale during the last year. Such limes have been picked when quite green yet fully grown; they are wrapped in tissue paper and packed in aerated boxes. The reports on the shipments exported have been favourable.

PAPER No. XVII.

METHODS OF CULTIVATION AND USES OF THE FOOD CROPS OF THE GOLD COAST.

COMPILED BY E. MARDEN COOK, DIP. AGR. (London).,
Assistant Superintendent of Agriculture.

The following information was collected systematically by many officers of the Department from various districts of the Colony, of whom the following must specially be mentioned :—Messrs Eady, Hewison, Vardy, Martinson, Clerk, Adakwa and Nkpe,—and was compiled at the Department's Head Office.

The question of producing food-crops in the Colony is becoming a very grave one, and it is obvious that the time is not far distant when some steps will have to be taken to produce more food locally and to reduce, or at least prevent the increase of, the present high importation of foreign foods.

The Colony is capable of producing most of its foods as there is a variety of country which is suitable to most crops now imported.

To take two of the most important foods imported, rice and sugar. There is great prospect of the rice industry developinf in Appollonia in the neighbourhood of the Twin rivers. There the soil is similar to that of Sierra Leone, where large areas of swamp-rice are grown. This district alone covers many acres and a Rice Factory has now been erected to deal with the crop.

How much of the sugar cane in the Colony is manufactured into the commercial product ? One sees small areas of cane all over the country and this simply finds its way to the local markets and is sold merely for chewing. Surely if a small area can be grown it can be increased to sufficient size to warrant the erection of a factory which could at least supply the local demand.

The Colony is 91,690 square miles in area with a population of 2,296,400 and the annual value of imports of foodstuffs into the Colony for the past 5 years averages about 3/6 per head of the population.

It is difficult to get out accurate statistics at present as to the yields of the locally grown foods owing to the methods of agriculture adopted by the people, but it is hoped that at an early period provision will be made for obtaining and publishing regular and suitable agricultural statistics.

Dr. J. M. Dalziel, M.D., B.Sc., F.L.S., Deputy Director of the Sanitary Services of the Gold Coast in 1922, gives a complete and comprehensive account of the composition of local foodstuffs together with other useful information on the problem in his article " The Foods and Diet of the Gold Coast People" Journal of the Gold Coast Agricultural and Commercial Society, Vol. I. No. 4 of July-September 1922, pp. 191-210.

TABLE I.

FOOD CROPS OF THE PEOPLE.

NATURE OF CULTIVATION.

Crop.	Native Name.	Botanic Name.	Time of Planting.	How Grown.	Harvesting.	Yield.
Yam.	Twi—*Ode*. Fanti—*Edwiw* (*Odu*).	Dioscorea alata.	Mar.—April	New areas cleared in Dec. to Feb. and mounds 3″-4″ high are made. Follows Corn, Ground-nuts, previous to Cocoa. Interplanted: Plantain, Vegetables, Yams.	6–12 month after-wards. Roots left in the ground to produce yam-heads for seed.	1–3 tubers per mound. 5–12 tons per acre.
Cocoyam.	Twi and Fanti–*Amankani*	Colocasia antiquorum.	Feb.—May first crop. Sept.—Oct. second crop.	Generally planted with Corn, Plantains and Cassava.	Remove as required after 9–12 months.	6–12 tubers per plot. 3–6 tons per acre.
Cassava.	Twi—*Bankye*. Fanti—*Bankyi*.	Manihot utilissima.	Mar.—April Aug.—Sept.	Cuttings inserted in ground after yams or corn and may be insert-ed for 3 years.	Red varieties 2 years after sowing. White 18 months after sowing.	4 or 5 roots per stand. 4—10 tons per acre.
Groundnut.	Twi—*Nkati*. Fanti—*Nkatsi*.	Arachis hypogea.	Mar.—Apr. July—Aug.	Grassland and old food farms Beds 4″-5″ high are made, seeds sown thickly 1½″ apart to guard against loss. Two crops taken and land reverts.	August—September Nov.—Dec.	6–8 cwt. per acre.

TABLE I.—*contd.*

Crop.	Native Name.	Botanic Name.	Time of Planting.	How Grown.	Harvesting.	Yield.
Bambarra Groundnut.		Voandzeia subterranea.	June—July.	Planted in small patches in the yam farm.	November.	1,000–1,500 lbs. per acre.
Onions.	Twi—*Gyene* Fanti—*Anwiw*.	Allium.	Mar.—Apr. Aug.—Sept.	New land, grown on raised beds 4″ apart in rows 6″ apart.	June—July. Nov.—Dec.	5–6 lbs. per bed of 3′ x 6′ apart.
Sweet Potato.	Twi—*Antomo* Fanti—*Santum*.	Ipomea Batatas.	May—June.	Planted in forest area. Land always ridged after yam crop.	October—November.	125 lbs. 2 tons.
Hausa Potato.		Dioscorea esculenta.	Mar.—May.	On mounds either on new land or old yam land.	Dec.—Feb.	12–15 cwt. per acre.
Tiger nut.	Twi—*Atudwi*. Fanti—*Atadwi*.	Cyperus esculentus.	Mar.—Apr.	Small circular beds in old yam country. 3′ apart 4-5′ between each plant on bed.	July—August.	800–1,000 lbs. per acre.
Corn.	Twi—*Aburo*. Fanti—*Eburo*.	Zea Mays.	Mar.—May. for 1st Crop Aug—Sept. for 2nd Crop	Usually on new areas. Ground loosened every 3′. 3–4 seeds put in. Inter-planted with Plantains, Bananas and Cocoyams.	June—July. 1st Crop. Dec.—Jan. 2nd Crop.	3 cobs per stand. 20–50 bushels per acre.
Rice.	Twi—*Emo*. Fanti—*Emu*.	Oryza sativa.	June—July.	Usually broadcasted on swampy land.	December.	720–1,100 lbs. per acre of paddy.

TABLE I.—*contd.*

Crop.	Native Name.	Botanic Name.	Time of Planting.	How Grown.	Harvesting.	Yield.
Millet.	Fanti—*Abom.*	Sorghum spp.	July—Aug.	Planted either on the flat or low broad ridges.	Dec.—Jan.	260–500 lbs. per acre.
Guinea Corn.		Sorghum vulgare	June—July.	Planted on ridges by Mohammedan people on old yam country.	December.	300–400 lbs. per acre.
Beans.	Twi—*Asedua.* Fanti—*Edua.*	Phaseolus lunatus.	Mar.—Apr. July—Aug.	Planted on the mixed areas with other crops: usually under the dead stumps of trees.	July—August. March—April.	4 to 6 bushels per acre in several pickings.
Tomatoes.		Lycopersicum esculentum.	Seeds sown in March and transplanted in May.	Sown in food farms.	September onwards.	10 to 50 per plant.
Peppers.	Twi—*Meko.* Fanti—*Moko.*	Capsicum frutescens, Capsicum annuum.	Mar.—Apr.	Planted in Yam, Corn, Cocoyam and Plantain country.	Aug.—Sept. up to Harmattan.	10–16 bushels per acre in several pickings, one picking makes 1 cig. tin full.
Bananas.	Twi—*Kwadu.* Fanti—*Kodu.*	Musa sapientum.	Feb.—May.	Sown in a yam garden after yams have been planted.	12 months and after.	100–300 bunches per acre.

TABLE I.—*contd.*

Crop.	Native Name.	Botanic Name.	Time of Planting.	How Grown.	Harvesting.	Yield.
Plantain.	Twi—*Brode*. Fanti—*Brodzi*.	Musa paradisiaca.	Feb.—May.	May be planted with yams or corn sown after they have germinated.	12 months after planting and will last 4–5 years.	100–300 bunches per acre.
Papaw.	Twi—*Brofere*. Fanti—*Broso*.	Carica papaya	Appear any time after clearing farm.	Usually sown by birds or in a wild state on food farms.	12 months onwards.	50–100 fruits in a period of two years.
Pine Apple.	Twi—*Abrobe*. Fanti—*Abarube*	Ananas sativus.	Mar.—June	Planted in Cocoa or yam farm.	12 months onwards.	1–3 fruit over 2 years
Orange.	Twi and Fanti—*Akutu*.	Citrus aurantium.	During rains.	Planted 15 ft. x 15 ft.	4–5 years old in their prime at 15.	200–700 fruits per year.
Sugar-Cane.	Twi—*Afwereu* Fanti—*Ahyiri*.	Saccharum officinarum.	Mar.—May.	Planted in marshy soil of lagoons and rivers.	From one year onwards.	15 tons cane per acre.
Coconuts.	Twi—*Kokosi*. Fanti—*Kube*.	Cocos nucifera.		Planted first in a nursery, then out into the plantation when they have germinated.	Sixth year onwards.	30 to 50 nuts per tree. 1,500–2,500 nuts per acre.
Akitiwa Neeli.	Fanti—*Akitiwa*		Mar.—May.	Sown around trees in a yam farm, or corn farm.	9–10 months later.	20–30 fruits per climbing stem. 200–300 plants per acre.

TABLE I.—*contd.*

Crop.	Native Name.	Botanic Name.	Time of Planting.	How Grown.	Harvesting.	Yield.
Bungu.			Mar.—May.	Sown among corn and yams.	Leaves taken when in sufficient quantity. Seeds 4–5 months after.	2–3 lbs. of beans per plant. 1 Cigarette tin full of seed from 8–12 plants.
Lampari.			Mar.—Apr. August.	Usually grown on an old yam farm; after crop the land reverts.	July—August. January—February.	100–200 lbs. per acre.
Sesameim.		Sesamum indicum.	Mar.—April.	On old yam or corn country. Land reverts afterwards.	Leaves plucked when required. 5 months later for seed.	150 lbs. of leaves per acre.
Suley and Rama.			Mar.—May. July—Aug.	Sown on low broad flat ridges in corn farms or round the house compound.	When leaves are required.	

Fruits commonly seen in or near farms include the Hogplum (*Spondias lutea*), the Avocado (*Persea gratissima*), the Mango (*Mangifera indica*), the Guava (*Psidium Guayava*), the Lime (*Citrus medica* var. *acida*), the Soursop (*Anona muricata*), the Sweetsop (*Anona squamosa*), and the Bread-fruit (*Artocarpus incisa*).

Name of prepared food.	Material used.	Method of preparation.
Fufu ..	Yams, Plantains, Cocoyams, Cassava ..	Peeled and boiled. When soft pounded in a wooden mortar, eaten with any soup.
Ampese ..	Yams, Cocoyams, Cassava, Plantains ..	Peeled or unpeeled and boiled; eaten alone or with soup.
Oke ..	Yam, Cocoyam .., Ripe-Plantains	Peeled, slice and fried with palm oil.
Kenkey ..	Corn	Quantity required soaked in water, ground the next day between two stones :—Soaked again the next day and ground finally after which the dough is allowed to ferment. Then put portion of dough into boiling water, turn into a pulpy matter, and mix with rest of dough thoroughly. Roll into balls and boil again until well cooked.
Garri ..	Cassava ..	Peeled, grated and put into water. Thoroughly washed and put through a sieve. The mother liquid being allowed to stand. Starch precipitated. The pap after drying is fried to form "Garri." This is eaten with sùgar and water or it may be eaten alone or with soup, especially palm oil.
Kokonte ..	Cassava ..	Peeled, split and sun dried. This forms material which is used as a sort of Fufu under the name "gigi."
Tatare ..	Rice ..	Pounded into flour, made into porridge with water, sugar and salt; mixed and eaten.

Name of prepared food.	Material used.	Method of preparation.
Porridge ..	Cassava ..	Peeled, boiled, mashed in water. To this is added salt.
	Corn, Millet.., Rice	Ground mixed with water and boiled.
	Yam, Cocoyam, Sweet Potato, Hausa Potato	The same as Cassava.
Soup ..	Palm nut ..	Nuts boiled, pounded in wooden mortar, mixed with water, passed through a sieve and liquid boiled until well cooked. To this is added garden eggs, tomatoes, chillies (ground) and salt.
	Groundnut ..	Nuts roasted gently; when browned, are peeled and ground between two stones. Water is then added to it; put over a fire and boiled until well cooked, adding chillies, garden eggs, and salt.

Use.	Materials used.
As flavouring	Chillies, Tomatoes, Onions.
Eaten raw	All Fruits, Tigernuts, Sugar-cane, Coconuts.
Cooked Vegetables	Tomatoes, Beans, Plantains, Bambarra groundnut.
Eaten roasted	Groundnuts, Corn, Plantain, Bananas, Tubers, Sweet-potatoes, Cocoyams.
Fats	Palm oil, Coconut oil, Shea butter, Nerri, Groundnut oil, Kernel oil.

PAPER No. XVIII.

REPORT ON COTTON SELECTION WORK IN BRITISH TOGOLAND, DEC., 1925-FEB., 1926.

F. N. HOWES, M.Sc., F.L.S.

Late Botanist, Department of Agriculture.

Cotton selection work was commenced in British Togoland during the 1925-26 season and was carried out at the Agricultural Station at Kpedshu, some 15 miles south of Ho on the Ho-Adidome road. This station may be taken as fairly typical of the cotton growing country of British Togo south of the Bame-Misahohe range; and is situated in open 'parkland' country with a very unevenly distributed rainfall of 45-50 ins. Before dealing with the different varieties on trial and with selection work in general, a brief account of the history of cotton production in Togoland formerly might not be out of place.

In 1900 the German Colonial Economic Committee despatched a deputation to Togoland to enquire into the question of cotton cultivation in the Colony, and to make necessary recommendations for the establishing of an export cotton industry. This resulted in the employment of an American cotton expert (J. N. Galloway) for a few years to superintend initial developments, and of four coloured men from Alabama to instruct natives as to correct methods of cultivation and handling of the crop. The first experimental station was at Towe where 100 acres were cleared and an agricultural training college incorporated with the experimental work. Later stations were started at Misahohe, Ho, Kpandu, Kete Kratchi, Atakpame and Sokode. indicating that stations were well distributed to serve the various cotton-growing areas. A steady increase in the amount of cotton exported from Togoland during the period 1902-1911 appears to have resulted as following figures indicate :—

1902	80	bales (550 lb. bales).
1903	128	,,
1904	519	,,
1906	857	,,
1907	1,205	,,

Unfortunately figures for subsequent years were not obtainable but considering the estimated export from British Togoland alone for the season 1924-1925 a considerable increase in production has taken place since 1911.

According to records of the varieties grown by the Germans a form of "*Gossypium punctatum*", similar to American Upland types, was found to be very suitable for areas in the neighbourhood of Sokode. Sea Island (*G. barbadense*) was introduced and is reputed to have done very well in the neighbourhood of Agu, Misahohe, and Atakpame. A kidney cotton (*G. brasiliense*) closely allied to Sea Island was grown with success in the Kpandu district. Egyptian cotton was introduced but proved a failure. Several hybrids from the above types were evolved, and for Southern and Central Togoland a form of "G. punctatum x Sea Island" and "G. hirsutum x Sea Island" proved most successful. Final conclusions were to the effect that for Southern Togoland the naturalized Sea Island was most suitable and for the central and more northerly areas American Upland types.

Nature of Cotton at Present Cultivated in British Togoland.

By far the greater portion of the cotton cultivated by the native in British Togoland belongs to that known amongst them as "Soncho" or "Deti-tor" ("deti"—cotton, "tor"—real). This Soncho is without doubt a form of *Gossypium peruvianum* Cav:. It is of vigorous growth frequently reaching a height of 8′—9′ in one season's growth. The staple of this cotton is inclined to be rough though very strong: it is as a rule markedly uneven.

In certain areas in Togoland a cotton closely resembling "Soncho" in general appearance but with the conglomerate or kidney type of seed is cultivated by the natives. This is probably a form of *Gossypium brasiliense* and is derived from seed introduced originally by the Germans and established in the Kpandu district. The relative distribution of "Soncho" and "kidney" cotton in British Togoland is interesting. For the country south of the range of hills running roughly from East to West through British Togoland (Bame to Misahohe) consists almost entirely of "Soncho" (*G. peruvianum*) no trace of "kidney" (*G. brasiliense*) being discernible, whereas on going north of this range "kidney cotton" is immediately encountered and is the dominant type. This state of affairs is in agreement with the statement made by a German trader of Ho (resident in Togoland since 1910) that it was found by the Germans that, roughly speaking, north of this range, which turns in a north-easterly direction on entering French Togoland, kidney cotton was found to be the more suitable, and south of it the Soncho or free seeded (Egyptian) type. Though cotton country north and south of this range might appear superficially to be similar closer observation discloses the fact that certain distinct differences in the vegetation do exist. The Borassus palm for instance—though extremely common south of this range is very rarely encountered north of it, and differences in the proportion of Ctenium to Andropogon species in the grass flora of these two areas are noticeable.

Brown Linted Cotton.

Apart from the above two varieties of cotton—both naked black seeded types—no other cotton can be said to be cultivated seriously by the natives in British Togoland at the present time. No trace whatsoever was seen of the wild tree cotton (*G. arboreum*) reputed as occurring in various parts of West Africa, and it was concluded that if existing at all in Togoland it must be confined to the more northerly areas. A few odd plants of a brown-linted cotton (*G. mexicanum* x *hirsutum*?) known under the Ewe native name of " Deti-chien " (" red-cotton ") were seen occasionally round native villages ; it is however of little interest as the staple is of poor quality (*vide* lint chart at end) and very short, varying in colour from rust coloured to very light brown. It is commonly stated that the natives esteem small quantities of buff lint for the working of designs but this is rather discredited by the fact that wherever native weaving is witnessed the coloured yarn of whatever colour is always the ready-dyed imported article.

Kadeanyigba.

A small-bolled white linted cotton, with small seed, bearing a white or cream-coloured fuzz was seen on some farms, particularly round Adeklu and Abuadi, though only a few individuals in each farm. This cotton known to the natives as " Kadeanyigba " is probably of *G. hirsutum-punctatum* origin, and the one under native cultivation before the introduction of other forms. It is not now liked by the natives and " Soncho " is everywhere preferred, no doubt on account of the naked seed of the latter and consequent ease with which it can be hand-ginned. In native spinning also it was found preference was expressed for " Soncho ". The lint of this " Kadeanyigba " cotton is of good colour and fine silky texture-fairly strong. The E.C.G.C. has reported well on it as will be seen from their remarks reproduced at the end of this report.

Possible Need of Jassid Resistant Cotton.

A brief visit was paid to the agricultural station at Abor (near Keta) early in December where the cotton was found to be in very poor condition, and appeared to the writer to be suffering severely from the effects of Jassid, particularly the " Soncho " plot. A few odd " Kadeanyigba " plants growing in amongst the" Soncho " were outstanding in having suffered only slightly from Jassid attack. Undoubtedly this is due to the hairiness of the "Kadeanyigba " plant, a strong contrast to the entirely glabrous nature of "Soncho". This is however a matter for the entomologist for authoritative opinion but is nevertheless interesting in that attention is drawn to the fact that it may be necessary to procure a Jassid-resistant cotton for the extreme south-western and coastal areas of the Colony if cotton is to be developed to any extent in them.

Position of Varieties on Trial at Kpedshu.

Owing to the excessive rains at the time of planting germination in the variety test plot was not good and numerous gaps existed throughout, reducing therefore the number of individuals from which

selection could be made. Gaps were most noticeable amongst the Upland types " Meade " and " Allen " and least so in " Soncho " and " Kadeanyigba ". The following variaties were grown at trial at Kpedshu during the season :—

	Variety.	*Origin.*	*No. of Plants.*
1.	Soncho	Togoland	116
2.	Kadeanyigba	,,	167
3.	Deti Chien	,,	67
4.	Meade	Nigeria	16
5.	Allen	,,	22
6.	Zeidabi	,,	40
7.	Kpalagunda	N.Ts.	50
8.	Kummanli	,,	44
9.	Sagai	,,	13

Of the above, several are obviously unsuitable as commercial types and it is proposed to drop them this coming season.

Gold Coast Northern Territory Varieties.—" Kpalagunda " for instance, a red-flowered tree cotton (*G. arboreum* Lim) indigenous to West Africa holds out no promise whatsoever as an annual commercial cotton for several seasons. It is very slow growing with a prolonged ill-defined bolling period and only commences to flower some two or three months after other types. The staple is short and of coarse texture though said to be superior to that of most Indian forms of *G. arboreum*. The habit of the plant is poor, side branches being bunched together and almost vertical : and in appearance distinct from all others, with roselle-like leaves and purple-red flowers. The ginning percentage of this type is very low.

The remaining two Northern Territory varieties are also not promising being of a most straggling habit, the one with buff or rust coloured lint. Whether this straggling habit is but temporarily due to the plants having " gone wild " owing to changed climatic and environmental conditions, or whether this is the natural habit it is difficult to say. The latter probability would seem the more likely. possible contamination might have occurred last year with "Sagai", and " Gummanli " are identical in external appearance (*Gossypium punctatum*, Sch. & Thon., var *" nigerica "*). A difference exists in the lint however, that of " Sagai " being shorter and weaker than that of " Gummanli ", and brown coloured throughout, though the colouration varies from light to dark brown from plant to plant. In " Gummanli "some plants with white and some with brown lint are to be found. The variety is said to be normally white and it is quite possible contamination might have occurred last year with " Sagai ". for the two varieties were grown side by side. The lint of both is short, average measurements from over a hundred readings in each case indicating eleven sixteenths for " Sagai " and thirteen sixteenths to fourteen sixteenths of an inch for " Gummanli ". As already stated neither varieties are promising and it proposed to drop " Sagai " entirely the coming season, but to continue for a while

with "Gummanli" in an endeavour to derive a pure white strain with improved staple length and habit. The comparatively heavy yield of the variety and its fair degree of resistance to boll shedding are the reasons that prompt this decision.

Nigerian Varieties.—The varieties grown from Nigerian seed " Meade ", " Allen ", " Zeidabi " (American Upland types), are superior in lint qualities to other varieties grown, but unfortunately do not seem at all well suited to conditions in Togoland, and are liable to profuse boll-shedding. Germination with these varieties is also bad as will be seen from the Table given on page 5. This state of affairs would appear to be in entire agreement with those in Southern Nigeria, where types such as " Allen " which thrive in the North, cannot be induced to do satisfactorily in Southern Nigeria.

Togoland Varieties.—The type known as " Deti Chien " already mentioned has an inferior brown lint even shorter than that of " Sagai ". The plant itself is very erect with large basal branches, it is however not worthy of consideration and is to be dropped the coming season.

The Togoland variety of " Kadeanyigba ", though little cultivated by the natives at the present time, is well worthy of consideration. The plant is a vigorous grower, bearing a fair number of lateral fruiting branches, and matures reasonably early. Germination is good and the type has the appearance of being well suited to local conditions, with fair immunity to boll-shedding. Selection work with this variety will be carried on extensively.

The remaining Togoland variety " Soncho ", now cultivated by the natives more than any other type, is equally as vigorous as Kadeanyigba and a heavy yielder, though possibly not quite so resistant to boll-shedding. The staple is uneven and on the short side and this will need to be carefully borne in mind during selection. The texture and colour of the lint are slightly inferior to that of Kadeanyigba. The lint of this variety in second and third years growth on native farms was found to average a shorter length than first season's growth : this is referred to later.

Selection Work at Kpedshu.

Selfing.—Inspection of the trial plots on arrival at Kpedshu immediately drew attention to the fact that undoubted cross pollination in some varieties had taken place the previous season, and that immediate steps were necessary to guard against this recurring. Consequently on all the selected plants flowers were " bagged " individually just before opening and the bags removed on the withering of the corollas, *i.e.*, after period of receptivity of the stigmas. By bagging at the right time—in the evening before the morning of opening— and a close tieing of the bags, self pollination is affected spontaneously, in addition to prevention of all chances of cross pollination. On removal of the " bag " from a

faded flower a small label was attached to the pedicel. This was necessary as it was impossible not to miss occasional mature buds, in addition to which many of the plants had already commenced flowering before work at Kpedshu was commenced.

In reaping the yield from each plant, seed-cotton from bolls bearing the tag indicative of self-pollination was kept separate from the rest, and the plants from this seed alone will be used in selection next season. The recording of other bolls was however necessary also in order to ascertain total yield per plant.

Promising Natural Hybrids.—That cross-pollination had taken place last year was indicated particularly in the Upland types where individuals in the " Allen " and " Zeidabi " rows bore buff lint, no doubt through hydridization with one of the brown linted varieties. " Soncho—Kadeanyigba " hydrids, outstanding on account of the shape of the leaves, and intermediate in form and degree of hairiness between the two parents, existed in both " Soncho " and " Kadeanyigba " plots.

Some of the natural " Soncho—Kadeanyigba " or possibly " Soncho—Upland " hybrids were found to have superior lint characters to those averaged by either of the parents. The following list of natural hybrids with lint lengths is interesting, these being some of the nineteen hybrids kept under observation at Kpedshu.

Hybrid	No.	28	yield	70.7	gms.	av. lint	length	19.3	sixteenths of inch.
,,	,,	65	,,	180	,,	,,	,,	16.7	,, ,,
,,	,,	35	,,	88.6	,,	,,	,,	18.1	,, ,,
,,	,,	33	,,	66.4	,,	,,	,,	17.6	,, ,,
,,	,,	57	,,	—	,,	,,	,,	17.8	,, ,,

The figures given above for the yield are of comparative value only, as a few pickings of the plots in which these plants occurred had already taken place before the hybrids were taken under control. Of these hybrids No. 28 is the most promising and will be carefully watched and the more promising of the progeny selfed this season with a view to fixing the type. The nature of the lint of this hybrid No. 28 will be seen from the lint chart attached to the end of this report. It possesses the superior colour and silkiness of the supposed Upland parent and not of the coarser Soncho type. It is also smooth-seeded, which though of no great commercial consideration would render its adoption by the native the more easy, a strong preference being shown by them for smooth-seeded cotton. These hybrids, including No. 28, are mostly large seeded with a somewhat low ginning percentage, running in the neighbourhood of 26%—28%. This is below that of Soncho and American Upland types, but in excess of the native cottons with the exception of " Kadeanyigba " with which it is about equal.

Score Card Adopted in Selection.

Selection was carried out with the following score card as a working basis—

SCORE CARD ADOPTED, BRITISH TOGOLAND 1925-1926.

A.—PLANT.

		Marks.	Total.
I. Productivity		15	15
II. Habit and Earliness of Maturity.			
a.	Erect v. recumbent	2	10
b.	Compact v. straggling	2	
	Early v. late maturity	6	
III. Resistance to Pests.			
	Insects	6	10
	Fungoid diseases	4	

B:—LINT.

IV. Length of Staple		25	25
V. Distribution.			
	Very uniform	5	5
	Uniform	3	
	Fairly Uniform	1	
VI. Regularity.			
	Very regular	7	7
	Regular	4	
	Fairly Regular	2	
VII. Strength.			
	Very strong	8	8
	Strong	5	
	Fairly strong	3	
VIII. Ginning Percentage.			
	25—35%	15	15
IX. Texture and Colour.			
	Good	5	5
	Fair	3	
	Medium	1	
		Total ..	100

The actual figures for the different varieties are as given overleaf, the columns headed by Roman figures correspond to the factors indicated by corresponding figures on the score card.

SONCHO.

Yield (gms.)	Ginning %.	Av. Lint Length.	*I.*	*II.*	*III.*	*IV.*	*V.*	*VI.*	*VII.*	*VIII.*	*IX.*	Total
No. 2 146	34.6	15.9	13	7	7	24	3	7	5	8	5	79
,, 3 151.6	31.3	13.1	14	8	6	2	3	4	5	2	1	45
,, 4 153.5	34.7	14	15	5	7	8	3	4	5	8	3	58
,, 5 111.3	34.9	13.2	2	5	4	4	3	2	3	9	3	30
,, 10 129.5	35.0	13.2	7	9	8	4	1	4	5	10	5	53
,, 11 109.4	33.3	13	0	8	3	6	5	2	3	6	3	36

(Nos. 1, 7, 8, 9, were ruled out on account of shortness of staple and Nos. 6 and 12 on account of fuzzy seed).

KADEANYIGBA.

Yield (gms.)	Ginning %.	Av. Lint Length.	*I.*	*II.*	*III.*	*IV.*	*V.*	*VI.*	*VII.*	*VIII.*	*IX.*	Total.
No. 2 158	24.8	15.7	11	7	6	20	5	4	5	6	5	69
,, 4 89	25.5	12.5	6	6	5	4	1	4	3	8	1	38
,, 5 142	26.6	12	10	6	7	3	3	2	3	13	3	50
,, 6 132	26.7	12.1	8	2	3	5	5	4	5	14	3	49
,, 7 128	21.59	11.9	8	4	6	3	5	4	5	2	3	40
,, 10 78	24.24	12.8	6	8	8	5	5	4	5	6	3	50
,, 11 141	26.22	15	10	9	7	18	5	4	8	12	5	78
,, 12 188	—	12.7	15	9	7	5	1	4	5	15	3	64

Nos. 1,3, 8, and 9 (discarded on account of shortness of staple).

ALLEN.

	Yield (gms.)	Ginning %.	Av. Lint Length.	*I.*	*II.*	*III.*	*IV.*	*V.*	*VI.*	*VII.*	*III.*	*IX.*	Total.
No. 1	187	28.6	15.5	15	9	8	18	3	4	5	7	5	74
,, 2	165	33.6	12.6	9	10	5	4	3	4	8	15	3	61
,, 3	53.4	30.9	12.7	1	8	6	6	3	2	5	11	3	45
,, 4	166.2	27.5	16.9	8	9	6	25	5	7	5	6	5	74
,, 5	175	25.8	15.5	12	9	8	18	5	7	5	2	5	71
,, 6	108.6	29	15.3	5	7	4	17	3	2	3	8	3	52

ZEIDABI.

	Yield (gms.)	Ginning %.	Av. Lint Length.	*I.*	*II.*	*III.*	*IV.*	*V.*	*VI.*	*VII.*	*VIII.*	*IX.*	Total.
No. 1	133.9	32.3	13.6	9	7	6	3	5	2	3	13	3	51
,, 2	76.7	31.1	14.1	5	9	3	9	3	2	3	7	5	46
,, 3	149.6	32.2	16.6	10	7	5	20	5	7	5	13	3	75
,, 4	95.8	29.7	17.1	6	8	9	24	5	7	5	1	5	70
,, 5	213.1	32.7	14.7	15	10	4	8	3	4	5	15	3	67
,, 6	119	31.9	15.2	7	9	7	17	3	4	3	9	3	62

GUMMANLI.

	Yield (gms.)	Ginning %.	Av. Lint Length.	*I.*	*II.*	*III.*	*IV.*	*V.*	*VI.*	*VII.*	*VIII.*	*IX.*	Total.
No. 1	85.3	25.3	18.4	15	9	8	24	3	4	3	1	3	70
,, 2	34.9	30.2	12.13	5	8	5	3	3	2	8	15	5	54
,, 4	70.3	26.1	13.8	12	10	5	6	3	4	3	4	3	50
,, 5	39.9	26.02	13.5	7	7	2	5	1	2	3	3	3	33
,, 6	36.1	26.8	13.9	6	8	7	7	1	4	3	5	5	46

(No. 3 relinquished on account of shortness of staple).

MEADE.

	Yield (gms.)	Ginning %.	Av. Lint Length.	*I.*	*II.*	*III.*	*IV.*	*V.*	*VI.*	*VII.*	*VIII.*	*IX.*	Total.
No. 1	266	26.0	14.1	12	10	6	23	5	4	5	13	5	83
,, 3	214	20.5	12.2	6	6	4	3	3	4	3	1	3	33
,, 5	155	21.7	12.2	1	5	6	3	5	4	3	2	3	32
,, 6	288	27.3	12.6	15	6	4	6	3	7	3	15	3	62
,, 10	225	24.5	13	7	8	7	10	3	4	5	8	5	57
,, 12	180	21.5	11.9	4	5	6	2	3	1	3	2	3	29

As has been indicated it has been decided to drop some of the above varieties this year notably " Sagai, " " Kpalagunda, " and " Deti Chien. "

Cotton of Several Season's Growth.

Several samples of cotton were taken from plants on native farms known to be of two or more season's standing. This was compared with Soncho of one season's growth and was found to be shorter and more uneven (to be expected) as can be seen from the following figures.

The figures in A represent staple-length measurements of lint drawn from 12 different plants on native farms of two and three years standing, whereas those in B represent staple-measurements of lint from plants in their first season's growth.

A.

No.	1 (12.12.12)	(11.13.11)	(13.13.13)	
,,	2 (10.12.12)	(13.12.12)	(12.13.12)	
,,	3 (13.12.14)	(13.14.13)	(14.15.14)	
,,	4 (10.11.10)	(10.13.10)	(9.11.9)	
,,	5 (14.12.13)	(12.13.14)	(12.13.12)	*Average* 12.19.
,,	6 (8.9.8)	(8.9.8)	(8.8.8)	
,,	7 (14.14.13)	(12.13.11)	(12.12.13)	
,,	8 (13.14.14)	(15.13.14)	(14.14.15)	
,,	9 (9.11.10)	(7.12.9)	(9.10.10)	
,,	10 (14.12.15)	(14.12.13)	(13.14.12)	
,,	11 (17.17.16)	(17.14.16)	(16.16.15)	
,,	12 (15.14.13)	(12.13.14)	(12.14.15)	

B.

No.	1 (11.12.11)	(12.12.12)	(12.11.12)	
,,	2 (10.12.10)	(10.12.10)	(12.10.10)	
,,	3 (11.11.10)	(10.12.10)	(12.11.14)	
,,	4 (13.13.14)	(14.12.14)	(14.13.14)	
,,	5 (14.15.14)	(14.11.14)	(11.14.14)	*Average* 13.12.
,,	6 (14.14.16)	(14.16.14)	(12.13.14)	
,,	7 (16.15.15)	(15.16.16)	(15.16.16)	
,,	8 (14.12.12)	(14.13.15)	(15.13.15)	
,,	9 (12.16.12)	(12.15.12)	(13.14.13)	
,,	10 (13.12.11)	(12.13.12)	(12.12.12)	
,,	11 (13.13.14)	(14.14.15)	(15.15.15)	
,,	12 (10.12.12)	(12.14.14)	(12.12.12)	

Report for the E. C. G. Corporation on Togoland Cotton.

In February two small consignments of " Soncho " and " Kadeanyigba " cotton grown in Togoland were forwarded to the Empire Cotton Growing Corporation. The lint, from plots on the station, was carefully hand picked to remove all stained cotton. A copy of the Empire Cotton Growing Corporation's reply is reproduced below from which it will be seen that

the qualities of the two lints (when free from stainer) are fair, though still on the short side. According to the broker's report "Kadeanyigba" lint is superior to "Soncho" the respective values being 11.15d. and 10.25d. based on March American futures at 9.5d.

It must not be lost sight of that these samples had all been picked free of stained cotton and that the normal native-produced cotton from Togoland with leaf and stained cotton in varying quantities would not be valued at these figures. However it indicates that the present cotton grown in Togoland when clean and stain-free is capable of realizing a good price, and that the elimination of stained cotton and instruction of the natives in clean-picking are probably quite as important as the establishment of superior longer linted types of cotton in Togo.

EMPIRE COTTON GROWING CORPORATION.

Millbank House,
2, Wood Street,
Millbank,
London, S.W.I.
25th March, 1926.

DEAR SIR,

I have to acknowledge with thanks the receipt of your letter of the 23rd ultimo under the above reference number. The samples of cotton duly arrived, and I have now received a report on them from Messrs. Wolstenholme and Holland, who are one of the most important brokers in Liverpool who deal with Empire-grown cottons. The samples are too small for spinning tests to be carried out upon them.

You will see from Messrs. Wolstenholme and Holland's report that sample B. is valued at 90 points on the value assigned to sample A. and that both are worth more than American futures. We shall be interested to hear the results of the trials with your selections from A. and B. which you are carrying out this season.

Yours faithfully,

L. G. KILBY,
Secretary.

WOLSTENHOLME & HOLLAND,
LIVER CHAMBERS, TITHEBARN STREET,
LIVERPOOL, *23rd March*, 1926.

Mr. J. C. MAY, Messrs., The Empire Cotton Growing Corporation, London.

DEAR SIR,

We consider the value and description of your Cotton samples from the Gold Coast.....to be this day as follows :

Mark.	Quality.	Description.	Value.	Classification &c.
A.	(Soncho).		10.25d.	Indigenous character, light brown in colour Staple rough full $1\frac{1}{8}$" fairly strong.
B.	(Kadean-yigba).		11.15d.	American character, Staple fairly fine and strong, about 1.1/16" @ $1\frac{1}{8}$".

Based on March American Futures—9.50d.

We are,

Yours faithfully,

WOLSTENHOLME & HOLLAND.

LINT CHART :

(*Description of Plate XVIII.*)

A photograph of a lint chart of Gold Coast and Togoland cottons is here reproduced. From this the superior long silky lint of natural hybrid No. 28 is noticeable, also the inferior and coloured staples of the varieties which are being dropped (Nos. 5, 6 and 7). The varieties represented in the photograph (Nos. 1 to 7) are as follows :—

No. 1. Natural Hybrid No. 28 Kpedshu Br. Togoland female parent (*G. peruvianum*, male parent unknown).
No. 2. " Soncho " (*G. peruvianum*) Br. Togoland.
No. 3. " Kadeanyigba " (*G. hirsutum-punctatum*?) Br. Togoland.
No. 4. " Gummanli " (*G. punctatum* Sch. & Thon. var. nigerica) Northern Territories, Gold Coast.
No. 5. " Kpalagunda " (*G. arboreum* Linn) Northern Territories, Gold Coast.
No. 6. " Sagai ' ' (*G. punctatum* Sch. & Thon form) Northern Territories, Gold Coast.
No. 7. " Deti-Chien " (*G. mexicanum-hirsutum*?) Br. Togoland.

(Thanks are due to the Director of the Royal Botanic Gardens, Kew, and Sir George Watt for providing specific identity of some of these cottons.)

PLATE XVIII.

PAPER No. XIX.

RECENT WORK IN THE EAST ON THE RELATIONS BETWEEN STOCK AND SCION IN BUDDING AND GRAFTING.

By G. G. AUCHINLECK, M.Sc., F.I.C.,
Deputy Director of Agriculture.

During a visit in 1926 to Sumatra, Java and Malaya, there were several opportunities of noting the great strides made by the Dutch and English in their knowledge of the technique of budding and grafting. These processes are used on a large scale for propagating selected strains of Hevea and Cinchona, and in the course of this work a great deal of information has been gained on the question of the relation between stock and scion.

In this article, free use is made of the information willingly given to the writer, and special thanks are due to Major Gough, of Kadjang Estate, Malaya, Dr. P. J. S. Cramer of the Department of Agriculture, Java, Mr. Grantham of Boenoet Estate, Sumatra, and Dr. Kerbosch of the Government Cinchona (Quinine) Plantations at Tjinjiroean, Java.

The Relation in General between Stock and Scion.

When two different strains of a plant are united by budding or grafting, it is taken for granted that the characters of each are carried on unchanged in the composite individual that results. The characters for which the stock has been chosen, such as vigour and resistance to drought or to disease, are assumed to be uninfluenced by the fact that a trunk and branches of quite different habits have been imposed upon the root-system. Similarly, the peculiarities for which the scion has been selected are assumed to be carried on unchanged, in much the same way as a cutting transmits the characters of the tree from which it is taken.

The union between stock and scion is very close, so close that, after a few years, it is practically impossible to detect any external evidence of the junction. The composite plant not only looks like one individual, but in ordinary matters of growth and nutrition it behaves like a single unit : the roots absorb a sufficiency of nourishment from the soil, the leaves extract the wanted quota of carbon from the air, and proportioned, symmetrical, balanced life and growth proceed.

Yet it is clear that the fusing of the two individualities cannot be complete. Certain characters of stock and scion remain distinct and different, and it is precisely this peculiarity which makes the process of budding or grafting valuable to us. The sweet fruits of the selected orange-scion do not become acid because they are borne on the stem and roots of a sour-orange stock. The small, delicately flavoured berries of Arabian coffee are not altered because the stem and roots are of the coarse and hardy Liberian species. The selected scion-stem of Hevea rubber retains its powers of yielding large quantities of latex, although it is mounted on the roots and stem of a coarse, unproductive stock.

So we learn that some characters and powers are altered by budding or grafting, while others remain unchanged. In general, the composite plant is a homogeneous unit, but in certain respects it has a dual individuality, two different degrees of intensity of a character existing unmingled in the same individual. An example of a character remaining distinct in the stock and scion is the occurrence of so-called "graft-hybrids," where a branch is produced which bears flowers of two colours, the origin of the branch being a vegetative bud springing from the line of junction between stock and scion: the tissue of the branch is apparently organically homogeneous, but really consists of united, interwoven tongues of tissues from two different sources; the tissue from the stock bearing one colour of flower and the scion-tissue bearing the other.

Interaction between Stock and Scion in Hevea Rubber.

By the act of budding, both the stock and the scion sustain a severe shock. Longitudinal growth of the stock is suddenly stopped by the decapitation of the young stem, and for some time afterwards there is a compensatory increase in the rate of circumferential growth. The case of the scion is exactly the oppposite, as the young bud suddenly finds itself driven by the full force of an older, powerful root-system.

In the case of Hevea rubber, four effects of practical importance result from this. The growth of the scion-stem to maturity is much more rapid and the tree becomes tappable at a much earlier age. The stem does not taper, as in normal unbudded rubber, but is of practically the same diameter from the point of junction up to the first branches, with the result that tapping may be carried out at any height and precisely the same amount of latex be obtained. The scion-bark is much smoother and harder than that of unbudded rubber, with the result that a clean, straight tapping-cut with firm edges can be made.

The case of the stock is otherwise. Circumferential growth is rapid, so that the bark becomes soft and corky and much rougher than that of unbudded rubber. In extreme cases, where the disproportion between the ages of the stock and scion is too great or where union has been tardy, the diameter of the stock may be so much greater than that of the scion that an unsightly tree with a permanent weakness at the budding-junction may result.

There is some evidence that the degree of rapidity and completeness of the union of stock and scion does not depend only on the relative ages of the two. In the earlier stages of the work of establishing plantations of budded rubber, very little attention was paid to the characters of the stock: it was assumed that seedlings from unselected trees would suffice as stocks for the delicate, high-yielding strains selected as scions. Experience showed, however, that some strains of scion seemed to possess the power of uniting rapidly and firmly, quite independently of the type of stock upon which they were budded, and that similarly some stocks seemed to unite well and quickly with any strain of scion. These observations point to the necessity for giving a good deal of attention to the choice of the stock, as well as to the selection of scion.

In the case of Hevea rubber, the latex-canal system of stock and scion remain distinct even when union has been so complete that the line of junction is barely detectable externally. In one set of trials, in which a wild type of Hevea with bright, sulphur-coloured latex free of caoutchouc was used as stock and a rubber-yielding strain with normal white latex was scion, no intermingling of the two types of latex-canal took place. Tapping of the scion could be carried right up to the line of junction of the two barks without any yellow latex appearing. Apparently a severed latex-canal becomes sealed at the end which has been cut and does not anastomose with any other canal which may come into contact with it, nor does it continue to grow and penetrate into the tissue on the other side of the cut.

This character is utilised in the treatment of 'Brown Bast', a disease which attacks the tapping-area and stops the flow of latex. It has been found that the diseased area can be permanently and effectively isolated by making an incision, without removing any tissue whatever, around it. The severed canals never unite across the incision, although the cut heals, and there is no transfer of the disease from the isolated area. Presumably the disease normally spreads through the medium of the latex-canals.

An analogous case was noted some years ago in the case of cacao in the West Indies. Alligator cacao (*Theobroma pentagona*) was budded on a Forastero type, and the stem of the scion was later attacked by a fungoid disease to which the Forastero stock was practically immune. The disease stopped at the line of junction of stock and scion, and eventually the scion was killed while the stock produced basal shoots and survived.

Constancy of Habit of the Scion.

In all cases noted in the East, the general manner of branching and the shape of the head were transmitted unchanged from the bud-mother to the scion-progeny. The fact is well known in the case of Hevea rubber, and there are indications that definite practical use will be made of the information, notably where a select high-yielding strain has some defect in its manner of

branching. A case in point is the tendency of some strains to produce a double trunk, the main trunk dividing into two at a distance of 8 or 10 feet from the ground. One of these trunks almost invariably atrophies and breaks off, and strains possessing this undesirable peculiarity will either be discarded or will be provided with a desirable branching-system by budding from a third strain chosen for the purpose.

A remarkable example of transmission of habit of branching from bud-mother to scion has come to light within recent years. In the case of most trees and shrubs the distinction between main branches and horizontal ones is not very marked. In the mango for example branches are found growing at all angles to the normal. But in coffee and kapok the distinction is very marked between the vertical stem and the horizontal laterals, and in cacao the habit of the tree is quite different from that of the vertically growing basal shoot or " sucker " with its distant whorls of three or five horizontal laterals.

In the case of these three plants, the habit of the budded progeny depends upon whether the bud has been drawn from a vertical stem or a horizontal lateral. Buds from the vertically growing stem give rise to scions of similar habit to the bud-parent. On the other hand, buds drawn from a horizontal lateral give rise to prostrate types, and many examples are extant of prostrate types of budded coffee and kapok which have originated in this manner. It seems clear that wherever a very marked differentiation exists between the manner of growth of the stem and that of the lateral the habit of each is transmitted unchanged to the bud-progeny.

Disappearance of Epidermal Prickles of Kapok.

The immense silk-cotton (kapok) trees which are found in West Africa and the West Indies have their stems studded thickly with prickles. These are true prickles, like those of the rose, being purely epidermal and not originating, as spines do, from the wood of the trunk. As the trunk ages and its bark roughens, the prickles are shed, so that they are found only on the relatively younger stems and branches.

The variety of kapok which occurs in Ceylon, Malaya and the Netherlands East Indies is slender-stemmed and never attains great bulk. Botanically it is regarded as identical with the West African type, but in size and in quality of lint the two are very distinct. The Eastern type, too, is without prickles.

It some budding experiments at Buitenzorg, Java, the Java type of kapok was used as stock and the Western type as scion. In each case, the resulting plants were free of prickles : in other words the stems of the scions resembled those of the smooth-barked Eastern type and not those of their bud-mothers. The explanation, probably correct, put forward of this unexpected result is that the scion overleaps the juvenile, prickly stage because it is mounted

on a vigorous, established root-system. It springs at once to maturity and does not pass through the preliminary stage of youth and pricklyness. The phenomenon is therefore a secondary one : there is no question of intermingling of tissues.

Extending the Range of Cinchona by Budding.

Practically all of the cinchona (quinine) plantations of Java use budding as the normal means of propagating their trees. The robust *Cinchona succirubra* is used as the stock and select high-yielding strains of *Cinchona Ledgeriana* as scions. The plants need very special conditions of moisture, elevation, temperature and soil in which to grow, and any wide departure from these conditions retards the development of the tree. Too low an elevation is stated to result in diminution of the percentage of alkaloid in the bark.

The normal profitable range of *Cinchona Ledgeriana,* when grown on its own roots, is 4,500 to 5,000 feet above sea-level, but the range of the hardier *succirubra* is 3,500 to 6,000. The composite plant built up by budding *Ledgeriana* on *succirubra* is stated to have the same range (3,500 to 6,000 feet) as *succirubra,* and the plantation-industry to have extended accordingly.

It seems to be accepted as fairly certain that change of elevation, quite apart from concomitant alterations of temperature and moisture, do affect the growth of cinchona and the percentage of alkaloid in the bark. If this be correct, it must be ascribed to variation of atmospheric pressure, and the influence of the scion had been fundamentally changed by the influence of these variations on the growth and life-functions of the plant. The extension off the elevation of *Ledgeriana* must then be regarded as an unusual and remarkable case of reaction of stock upon scion. In a budded plant, the main body of the tree is the delicate *Ledgeriana* and only the root-system is *succirubra,* so that one would not expect any marked change in power of resistance to altered pressure, to be brought about by budding, unless the nature of the scion had been fundamentally changed by the influence of the stock. More explicit evidence is needed of the true effect of change of elevation apart from the masking effects of altered temperature and soil conditions.

Programme of Work needed in the Gold Coast.

This paper has been written in order to direct attention to difficulties which may arise when budding and grafting receive attention in the Gold Coast. In this Colony, no evidence has been gathered on the uses and results of budding, but it seems clear that very marked increases in yield could be brought about in the cases of several local crops if a systematic programme of selection, budding and grafting were adopted.

Some preliminary work of selection has been accomplished by recording the yields of individual trees of cacao and cola on some of the Experiment Stations, but the further step of using the best of these trees as scions, and of spreading them over the country, has been neglected. There is also the possibility that coffee, kapok and the citrus group may become of commercial importance in future years, and, in that case, a study of the effects and uses of budding and grafting will be imperative. Work of this kind has been too long neglected in the Gold Coast, and should be set in hand as early as possible.

PAPER No. XX.

SCHOOL GARDENING.

By T. HUNTER,

Superintendent, Training Centre, Kumasi.

The School Garden movement was in existence during early mission days but no records are available. Classes in Agriculture for School Teachers and Students under training was arranged for in 1902 at the various Agricultural Stations, but no candidates were available until 1904, since when these classes have been continued up to date.

Teachers' Training Classes.

The course is divided into two sections which are taken during school vacations in January and July, each course occupying three weeks. Lectures and demonstrations are given daily for about one to one and a half hours, the remainder of the day being spent in performing practical work in the field, under the supervision of the officer-in-charge of the Agricultural Station where the course takes place.

The training, briefly stated, embraces the following :— The plant and its requirements of air, soil and water ; structure and functions of various plant organs, seed, seed dispersal, etc. Soils, formation, classification—chemical and physical properties. Cultural operations, digging, hoeing, manuring, mulching, draining, study of soils and climatic conditions suited to various crops, insect pests, and fungoid diseases. Formation and management of School Garden. Practical work—uses of various tools required for the School Garden. Nursery work—methods of propagating plants, potting, transplanting and watering. Soil tillage—lining, holing, planting, and various cultural operations ; harvesting and preparation of various crops. Practical treatment of fungoid diseases and insect pests.

No figures are available as to the actual number of teachers who have taken these courses, but 916 certificates have been awarded resulting from the examinations held at the end of each course between the period 1904-1925.

Results.

It has frequently been observed that the students deriving greatest benefits, are those who have received tuition in Training Colleges where Nature Study has received special attention. This tends to illustrate the need for a closer connection beween Nature Study and practical work in the garden which has not received the attention it deserves.

The results of the above courses have been fairly satisfactory when it is considered that the courses are very short, and arranged to fit in with the school vacations. These unfortunately, are not the best times of the year when the more important work of an Agricultural Station is carried out, and for a long time it has been recognised that much better results would be obtained if a more extensive system of training could be carried out throughout the whole of the Teachers' training.

When one examines the work done in School Gardens in this country it would appear that, with few exceptions they have not fulfilled their purpose.

This state of affairs is not peculiar to this country, and many more advanced countries have only in recent years paid proper attention to School Gardens.

The writer has been in close touch with many of the School Gardens during the last fifteen years, and is in a position to sympathise with the teachers who have worked under great disadvantages. Many of the teachers have tried to fully understand the work, but lack of organisation and necessary supervision have been largely responsible for the indifferent results.

A teacher in this country is naturally restricted in his efficiency. He is unable to apply his knowledge to unusual conditions, or prepare for anticipatory action where initiative is required.

Patience and frequently repeated instructions are essential to get him to understand what exactly is required, and this is only possible where frequent inspections can take place.

Reasons for Partial Failure.

The Education and Agricultural Departments have worked in close co-operation, but when it is realised that until the last few years, at most one European Agricultural Officer was available in each Province, and the inspectorate staff of the Education Department only allowed for occasional visits of inspection to schools, the indifferent results under such conditions can be readily understood ; further in many cases owing to frequent changes of teachers, there has been a lack of continuity in carrying out plans thereby limiting the possibility of success.

During the period 1915 to 1920 the writer paid quarterly visits to the five gardens in Kumasi in addition to many others in Ashanti during tours of itinerant work. A Circular, together with type-plan, was drawn up outlining what was required in a garden, and many teachers showed quite good results in following this plan.

One teacher in particular did extremely well, but unfortunately was transferred to another sphere of work just as the results began to show themselves, and the subsequent teachers were not so keen, therefore the good work originally done gradually deteriorated until the Garden was eventually abandoned.

As a general rule when inspecting School Gardens, one cannot fail to observe the outlook of drudgery that must appear at the back of the pupils' mind during garden work. The interesting part of the work, training the pupils powers of observation—the wonders of nature study and plant life, are usually neglected and what lessons are actually conveyed to the pupil leave him with at the most but a vague knowledge of such.

The Teachers' Function.

The connection between Nature Study and School Garden work is too little understood; the many useful lessons which might be carried from the class-room to a garden and, *vice versa*, are rarely attempted.

The value of such work depends on the teachers, and although the practical work—so far as agriculture is concerned—is often well carried out, few teachers take sufficient close interest in the work they have in hand. Endeavours should be made to make the pupil realise that the plant he cultivates is a living organism, which requires attention regarding feeding and environment, as he himself does, and that both require food and air to lead an organised existence; further, how dependent we are on the green plant, for all our necessaries of life.

An example of a teacher's inability to apply himself to lessons in a practical manner was recently experienced by the writer. A teacher, about to give a lesson on fungoid diseases, wrote to the nearest Agricultural Station and asked for specimens for demonstrating purposes. In this particular case a large rubber plantation is almost opposite the school, a large cacao farm within 200 yards, and many food farms near by, which would have provided all the material required.

A visit to any of the farms in question would have been of far greater value than an attempt to demonstrate fungoid diseases in a class-room. This shows lack of thought on the teacher's part which frequent inspection and guidance should remedy.

School Gardens to be effective, must be definitely organised, the teacher's training improved, and work frequently inspected to obtain the best results.

One frequently sees plans for pupils' training in School Garden work, but no thought is given to the teachers' training, which is the first essential to sucess.

In an agricultural country like this the teachers' training should be based on agriculture, and do this successfully it must be carried on throughout the college career.

Work at Wesley College.

During the past year a scheme of work has been laid down at Wesley College, Kumasi, which indicates the lines on which teachers' training can be carried out. Throughout the four years'

training, four hours per week are alloted to practical work in agriculture carried on in the School Garden. A plan has been drawn up which is worked as follows :—

A. First Year Students are mostly engaged in keeping the school surroundings neat and tidy. This enables them to become acquainted with their surroundings, and carry on preliminary studies.

B. Second Year Students take up cultivation in groups in the agricultural plots.

C. Third and Fourth Year Students have individual plots from which one can form a good idea of the interest shown by the individual, and allow for a competitive spirit amongst students.

D. Useful diaries are kept by students, and they are encouraged to make entries respecting work done, and to record general observations.

General food crops such as cassava, corn, coco-yams, yams, onions, okroes, are grown. A fruit-orchard and nursery have been formed. All crops are used in the college kitchen. Each student is credited with the value of crops produced from his plot, and prizes are awarded each term to the most successful students. A plan of the lay-out of the garden is given in Plate XIX. The system of rotation used is as follows :—

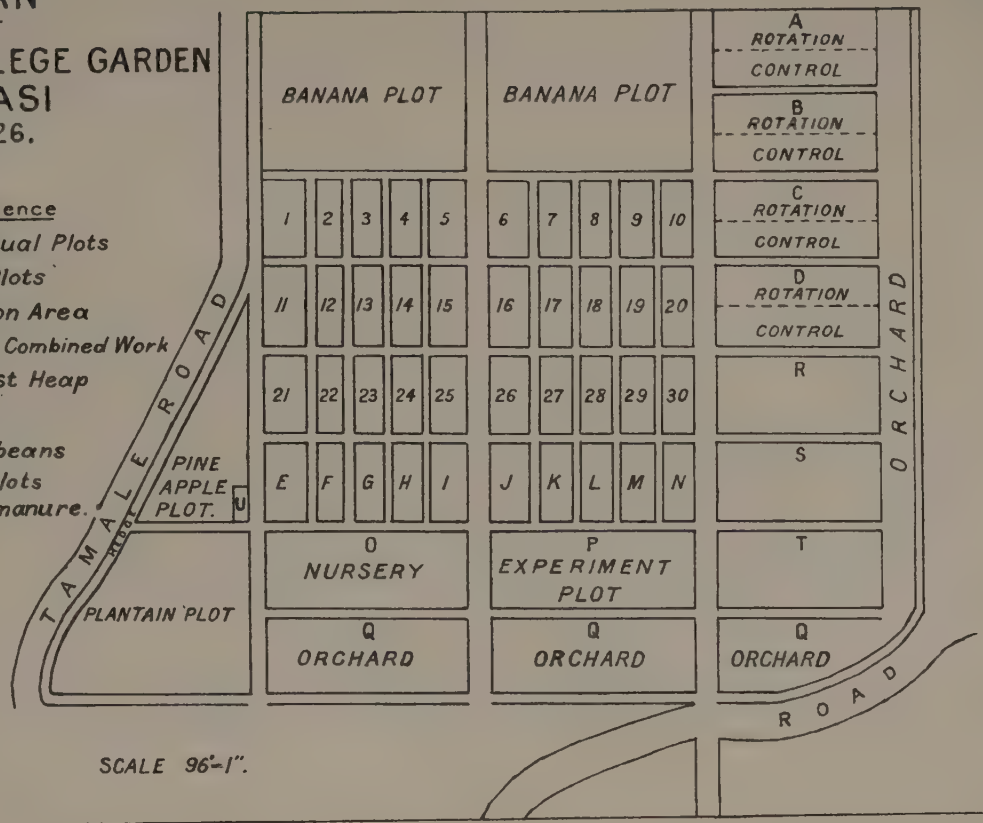
SUMMARY OF ROTATION AND CONTROLS.

Year.	PLOTS							
	A		B		C		D	
	Rotation.	Control.	Rotation.	Control.	Rotation.	Control.	Rotation.	Control.
1926.	Corn.	Corn.	Yam.	Yam	Tomatoes and Garden eggs.	Tomatoes and Garden eggs.	Ground nut.	Ground nut.
1927.	Yam.	Corn.	Tomatoes and Garden eggs.	Yam.	Ground nut.	Tomatoes and Garden eggs.	Corn.	Ground nut.
1928.	Tomatoes and Garden eggs.	Corn.	Ground nut.	Yam.	Corn.	Tomatoes and Garden eggs.	Yam.	Ground nut.
1929.	Ground nut.	Corn.	Corn.	Yam.	Yam.	Tomatoes and Garden eggs.	Tomatoes and Garden eggs.	Ground nut.

N.B.—1. Same crops to be grown on the Control Areas during the four years as shown in the Summary.

PLATE XIX.

PLAN
OF
WESLEY COLLEGE GARDEN
KUMASI
1926.



Reproduced at Survey H.Q. Accra, 1927.

This arrangement enables the students to form a good idea of what is required and how to manage a School Garden; further, having worked continously for four years, it gives the students an opportunity to see results and the varying conditions which exist, therefore he learns where anticipatory action is necessary.

Regular visits to Kumasi Agricultural Station, and local farms, are arranged for the purpose of general observations and study of agriculture.

Perennial Crops Inadvisable.

Although intensive cultivation of food crops is of most value and permanent crops are not really subjects for School Gardens yet each teacher should have a knowledge of the cultivation and preparation of our most important crops, diseases and pests, and how to control them. This is where excursions to Agricultural Stations and local farms are of value.

The general principles outlined for teacher's training should be carried out in practice in the ordinary School Garden, and the pupils encouraged thereby to take a more intelligent interest in the work undertaken.

In every school the children should be taught how much better it is to have one's surroundings neatly planted, and how valuable shade trees are as protection from the sun. Small nurseries should be maintained at all schools to raise plants, not only for the school surroundings, but also for the pupils to take home; the latter affording an excellent opportunity for developing individual taste and serving as a demonstration to others who have not had the opportunity of attending school.

Teachers while in the garden should bring to the pupils' mind some lesson apart from the actual work in hand. A few moments spent observing the germination of seeds etc., measuring and recording the growth of plants since a previous visit, and similar observations would encourage pupils to realise that their labours are not in vain, or devoid of interest.

Suggestions.

A teacher, especially in country districts, should be encouraged to do something to gain the confidence, not only of the pupils, but also the people with whom he comes in contact. He should be able to impart useful information to the farmers around him and help to advise and guide them in matters which they do not understand.

Health Weeks are now an annual feature of our large towns. Why not a health week on our cacao farms? The subject affords plenty of scope for action on the part of teachers and pupils.

To carry into effect the scheme outlined above we must have efficiently organised supervision, with a definite object in view. An Organiser of School Gardens is necessary, and a proportion of the teachers should specialise in Nature Study and School Garden work. Wood and metal work in the larger schools have special Instructors. Surely Nature Study and School Gardens are worthy of similar attention.

Such teachers must have sufficient time to prepare lessons in order to make them of utmost value. From these teachers it would be possible to select inspectors who should be trained to travel round organising the work for smaller School Gardens so that all might be worked according to a uniform system. This latter would of course have to be arranged to suit the localities, rainfall, periods of drought etc.

PAPER No. XXI.

RAINFALL OF THE GOLD COAST FOR THE YEARS 1925–1926.

(Records compiled in Head Office by J. M. Adams).

Past records of rainfall of the Gold Coast for 57 stations were summarized up to the end of 1924 in Bulletin No. 2 of the Department of Agriculture. The following stations, records of which were given in that Bulletin, had been discontinued before 1925 :—

Ada, Birimsu, Bunsu, Cape Coast, Gambaga, Goaso, Labolabo, Navrongo, Nkwatia, Obuasi, Winneba.

After 1925 the following stations were discontinued :—
Ayinasu, Adebrem.

On the other hand, the following new stations provided records in 1925 and 1926 :—

1925. *Achimota, Mpennasa.*
1926. *Adeja, Agona, Angu, Asromaso, Atuabo, Dentin, Effiduase, Ejisu, Essuasu, Inchaban, Kodia Kese, Mampong (Ash.), Mpirim, Nkawkaw, Nsawam, Tafo, Tikrom.*

There are therefore records from 48 stations in 1925 and from 63 stations in 1926.

The Department of Agriculture is indebted, for the records from the ten Ashanti stations opened in 1926, to Capt. C. Wilson Brown, the Senior Hydraulic Engineer, Public Works Department. Several of the stations are in an area from which there has been a dearth of information in the past, and the figures will therefore be of unusual value.

Check Readings.

In two cases in 1926, records were obtained from two different gauges at the same station. An opportunity was therefore afforded for the first time of judging the accuracy with which records are taken.

Results were as follows :—

	Sekondi.		Tarkwa.	
	Railway.	Medical.	Railway.	Agriculture.
January ..	.30	.37	—	—
February ..	.71	.90	—	—
March	2.20	2.21	4.42	4.82
April	1.03	1.12	3.92	3.35
May	5.36	5.98	7.95	7.09
June	9.68	10.13	21.49	19.68
July	.46	.40	1.60	1.77
August	.34	.24	2.02	2.12
September ..	3.43	3.55	5.44	6.09
October	2.73	2.76	10.53	10.25
November ..	4.13	4.24	10.06	11.23
December ..	.95	1.08	4.51	5.40
Total ..	31.32	32.98	71.94	71.80

In the case of Sekondi the largest variation for one month was .62 of an inch in May. In June the Railway reading for Tarkwa was 1.81 higher than that of the Department of Agriculture. In each case the year's totals were practically the same.

Rainfall Tables.

Tables II and III, at the end of this paper, give the monthly rainfall at each station for 1925 and 1926. These tables also give the highest and lowest rainfalls recorded in previous years at each stations.

Unusual rainfalls in 1926 were those at Accra (10.84) and Labadi (10.78). These are lower than have ever been previously recorded in any part of the country.

Degrees of Wetness.

In attempting to form some judgment as to the wetness or dryness of a particular place, we are met by the difficulty that a mere statement of the total amount of rainfall per year, or even per month, does not suffice. The distribution of the annual rainfall is clearly an important factor. Fifty inches well distributed over the year is more beneficial than seventy-five falling in certain months and drought for the remainder of the year.

In Table I, an attempt is made to combine the two factors. The number of inches of rainfall for the year is multiplied by the number of days on which rain fell. In order to reduce the product

to convenient dimensions, the last two whole numbers are discarded in each case: thus a rainfall of 80 inches falling on 120 days in the year gives a product 80 x 120 = 9,600, and, discarding the last two figures, 96 is taken as the degree of wetness.

All that can be said at present is that this figure appears to give a better notion of the comparative wetness of a station than does the figure for total annual rainfall or for number of days on which rain fell when either is separately considered.

TABLE I.

DEGREES OF WETNESS.

Inches of rain x number of days of rain.

1925.		1926.
—	160	Axim.
—	125	Tarkwa.
Begoro	110	—
—	103	Abompasu.
Asamankese	101	—
—	98	Kibi, *Kodia Kese.*
Abompasu	95	—
Tarkwa	90	*Mpirim.*
—	89	*Agona.*
Kumasi	87	—
Siwum	85	—
—	84	Siwum.
—	83	Juaso.
Kibi, Juaso	82	Kintampo.
Kintampo	81	—
Axim	80	Anyinam.
Ayinasu	79	—
—	78	Dunkwa, Kumasi.
Hemang	76	Half Assini, Seysie.
—	75	*Ejisu.*
Dunkwa	74	—
Oda, Mpraeso	73	—
Aburi, Kete-Krachi	71	Wiawso.
—	69	Asamankese.
—	68	Mpraeso.
—	67	Begoro.
Ejura	63	—
Asuansi	61	*Mampong* (Ash.)
Seysie, Ho, Wiawso	60	—
—	58	Oda.
Mansu, Wa	54	*Tafo,* Koforidua.
—	53	*Nkawkaw,* Asuansi.
Sunyani	52	*Tikrom.*
Bekwai, *Adebrem*	51	Wenchi, Mansu, Mpennasa.
Wenchi	50	Ho, Ejura.
Kpedshu	49	*Esuasu,* Aburi.
Mpennasa, Yendi, Tamale	48	*Nsawam.*
Adjua, Salaga, Koforidua	47	Kete Krachi.
Half-Assini	43	Adjua.
—	42	Bekwai, Hemang.
—	41	Tamale.
Sekondi	40	*Angu,* Sunyani.
—	38	Salaga.
Odumase	36	—
Anyinam	35	Sekondi.
—	31	Odumase.
Zuarungu	29	—
Peki Blengo	28	Kpedshu.
—	27	Peki Blengo.
—	26	Yendi.
Abra, Accra	24	Akuse.
Akuse	23	Zuarungu.
Saltpond	22	—
—	18	*Atuabo,* Abra, Wa.
Keta	16	—
—	12	Saltpond.
Labadi	11	—
—	10	Keta.
—	8	*Achimota.*
—	6	Accra.
—	3	Labadi.

N.B.—Names of stations for which only one year's record is available are printed in italics. Adeja, Asromaso, Effiduase and Inchaban do not appear as these stations were opened only in middle of 1926.

TABLE II.

Summary of Rainfall in inches for all Stations in the Gold Coast for the year 1925.

Month.	1 Asamankese.	2 Siwum.	3 Tegoro.	4 Dunkwa.	5 Ayinasu.	6 Kibi.	7 Axim.	8 Kumasi.	9 Yendi.	10 Salaga.	11 Juaso.	12 Abompsu.	13 Ejura.	14 Kintampo.	15 Oda.	16 Half-Assini.
January	.00	.00	.00	.00	.00	0.8	0.45	.00	.00	.00	.00	.00	.00	.00	.00	.00
February	1.85	0.68	1.98	0.70	0.39	3.76	0.55	1.10	.00	0.56	.00	1.99	3.28	1.30	1.61	0.20
March	8.57	6.07	10.43	9.60	7.06	10.42	12.25	8.79	3.01	5.50	6.57	11.28	6.57	4.19	6.50	8.65
April	10.48	8.49	6.17	7.80	6.10	8.69	6.06	4.67	3.11	1.60	3.03	4.61	2.66	1.67	11.67	6.45
May	9.37	11.07	7.74	10.95	7.03	9.47	5.75	8.09	6.45	7.06	5.58	7.91	8.94	7.43	6.90	9.57
June	14.48	14.87	10.87	20.44	13.02	10.45	26.26	9.52	6.87	8.40	12.43	11.86	3.24	6.61	9.41	24.70
July	3.94	14.06	3.76	7.56	9.53	4.34	11.63	7.25	3.59	7.84	12.33	3.23	6.38	10.14	7.24	5.90
August	6.24	4.57	10.67	5.06	5.65	3.15	1.37	6.48	16.30	9.65	4.27	8.09	5.36	6.35	6.13	.00
September	5.34	5.25	5.87	5.27	7.41	3.01	2.36	4.66	20.05	10.20	4.27	6.14	6.28	9.63	5.38	0.86
October	4.70	3.14	8.85	0.67	5.77	5.31	0.12	8.88	6.96	9.80	8.58	1.19	11.43	10.23	2.89	0.70
November	4.79	4.95	5.76	3.59	4.43	9.62	0.69	7.56	0.78	5.22	7.26	5.26	8.32	4.92	3.95	3.07
December	7.71	0.47	0.76	0.55	3.64	1.62	1.92	0.24	.00	.00	0.99	3.62	0.03	.00	.00	1.53
Total	77.47	73.62	72.86	72.19	70.03	69.92	69.41	67.24	67.12	65.83	65.31	65.18	62.49	62.47	61.78	61.63
No. of Rainy Days (.01 inch or more)	130	115	151	103	113	11 8	116	130	72	72	125	146	101	129	118	71
Highest previous rainfall	—	—	—	77.91	68.60	79.90	109.65	70.40	—	64.52	75.19	—	80.75	100.58	83.75	—
Lowest previous rainfall	—	—	—	45.55	41.95	45.77	47.64	40.07	—	37.79	53.42	—	47.45	48.87	43.61	—

TABLE II.—*continued.*

1925.—*continued.*

Month.	17 Mpraeso.	18 Wenchi.	19 Hemang.	20 Wa	21 Mpennasa.	22 Mansu.	23 Tarkwa.	24 Seysie. (Butre).	25 Aburi.	Wiaso.	27 Anyinam.	28 Bekwai.	29 Adjua.	30 Kete Kratchi	31 Peki Blengo.	32 Asuansi.
January	.00	.00	.00	.00	1.63	.00	.00	2.45	.00	.00	.00	.00	.00	.00	.00	0.18
February	0.42	1.29	0.04	.00	1.85	0.80	1.19	1.25	2.68	0.32	.00	1.00	1.32	1.04	2.80	0.35
March	7.87	1.94	6.73	1.82	3 21	6.43	8.32	3.88	5.38	6.66	.00	8.60	3.40	4.65	2.25	4.18
April	3.74	7.77	7.15	1.07	4.15	4.85	4.67	2.18	6.05	6.93	6.97	2.00	2.70	3.54	7.06	2.41
May	9.97	4.47	6.76	11.02	6.18	4.35	6.80	9.86	8.23	8.61	7.00	7.00	3.43	5.16	8.12	6.74
June	7.61	8.33	15.58	4.54	23.90	20.80	16.04	24.38	14.16	11.94	11.31	11.75	25.08	4.82	6.00	15.40
July	2.43	5.43	5.74	5.43	10.55	7.47	7.79	8.06	4.34	8.50	5.21	3.75	12.26	5.32	2.72	5.39
August	5.78	388	1.89	11.54	1.49	1.17	2.26	1.16	2.65	2.87	2.69	6.75	1.22	11.47	5.31	3.04
September	7.25	11.01	9.36	17.68	1.91	4.21	4.31	2.73	3.35	5.22	6.32	4.50	2.19	8.41	5.14	5.64
October	10.00	12.29	1.57	4.81	0.27	2.86	1.66	0.27	2.74	1.33	11.60	3.50	2.09	5.53	3.38	1.73
November	4.65	3.94	5.50	2.45	3.18	2.67	4.87	0.75	4.71	3.83	4.68	6.25	0.31	4.19	8.26	0.99
December	1.44	0.60	0.04	.00	1.95	3.77	1.20	1.99	2.93	0.87	0.39	0.50	1.50	.00	1.16	5.99
Total	61.16	60.95	60.36	60.36	60.27	59.38	59.11	58.96	57.22	57.08	56.17	55.60	55.59	54.13	52.20	52.04
No.of Rainy Days (.01 inch or more)	120	83	126	89	80	91	153	102	124	105	63	91	85	132	53	118
Highest previous rainfall	85.26	—	85.86	50.71	—	83.70	95.03	—	73.16	—	95.07	104.90	49.03	60.41	68.46	74.17
Lowest previous rainfall	57.55	—	58.64	30.65	—	54.46	48.22	—	32.09	—	46.27	53.64	30.81	43.61	30.33	35.62

TABLE II.—*continued.*

1925.—*continued.*

Month.	33 Kpedshu.	34 Koforidua.	35 Sunyani.	36 Adebrem.	37 Ho.	38 Odumase.	39 Tamale.	40 Sekondi.	41 Zuarungu.	42 Accra.	43 Saltpond.	44 Labadi.	45 Keta.	46 Abra.	47 Akuse.	48 Achimota.
January	0.23	.00	.00	.00	0.03	.00	.00	.00	.00	.00	1.07	0.62	.00	0.50	0.35	—
February	3.94	1.08	0.11	0.71	0.72	.00	.00	0.30	0.55	1.87	0.90	0.90	.00	0.16	2.10	—
March	5.91	4.41	5.82	4.66	7.57	.00	1.77	2.83	1.44	4.43	6.26	6.65	4.22	4.03	2.75	3.36
April	3.97	8.29	2.12	5.45	8.16	4.25	2.12	3.58	1.53	3.58	1.76	2.28	1.83	2.02	5.19	2.97
May	4.42	4.88	6.74	5.41	7.01	2.93	3.99	6.42	3.11	1.21	3.48	0.90	7.49	5.50	5.04	1.30
June	9.48	13.08	10.40	16.85	5.28	4.50	5.94	19.34	8.39	23.96	17.63	23.32	17.56	15.33	5.06	11.62
July	3.69	2.49	10.06	9.51	3.14	4 66	2.74	5.78	3.82	0.89	3.06	.00	3.95	2.75	1.66	2.30
August	6.21	2.02	4.56	2.48	5.06	3.56	5.71	1.27	8.18	1.64	0.77	1.60	1.03	0.58	2.92	0.41
September	5.72	4.11	4.47	2.60	4.61	6.89	13.28	2.35	7.30	0.72	1.01	0.40	0.30	1.98	3.65	1.86
October	4.31	8.48	6.57	0.30	3.13	10.44	7.57	0.48	5.05	0.02	0.09	.00	.00	0.10	1.11	.00
November	2.34	1.82	4.04	1.12	3.27	9.36	2.65	0.34	0.45	0.08	0.04	.00	.00	0.01	1.14	.00
December	1.73	1.12	.00	1 34	1.79	.00	.00	1.02	.00	0.09	1.02	0.20	.00	1.22	1.62	0.27
Total	51.95	51.78	54.89	50.43	49.77	46.59	45.77	43.71	39.82	38.49	38.09	36.87	36.38	34.18	32.59	24.09*
No. of Rainy Days (10 inch or more)	95	90	103	101	120	77	104	91	73	63	58	31	43	63	70	57
Highest previous rainfall	—	—	69.47	—	—	—	61.77	57.76	51.62	44.20	43.80	—	51.44	—	58.98	—
Lowest previous rainfall	—	—	41.30	—	—	—	32.36	33.80	37.93	15.87	24.38	—	13.88	—	35.14	—

*Figures for 10 months only.

TABLE III.

Summary of Rainfall in inches for all Stations in the Gold Coast for the year 1926.

Month.	1 Half-Assini.	2 Kodia Kese.	3 Axim.	4 Tarkwa.	5 Essuasu.	6 Kibi.	7 Siwum.	8 Anyinam.	9 Kintampo.	10 Abompasu.	11 Agona.	12 Mpirim.	13 Juaso.	14 Ejisu.	15 Dunkwa.	16 Tafo.
January	1.76	0.21	.99	.83	1.27	.86	.00	.00	.00	.26	0.40	0.84	.85	.00	.10	1.18
February	1.81	0.94	2.38	1.51	0.00	.81	4.00	2.40	.00	.52	3.52	3.54	.26	4.49	.74	0.68
March	5.81	5.69	3.26	4.82	6.57	10.03	5.35	6.84	4.51	4.04	3.31	1.67	4.03	3.71	2.77	3.74
April	7.90	9.52	0.81	3.35	3.31	8.03	8.34	7.59	5.89	4.38	6.70	11.86	9.14	8.25	6.73	5.83
May	16.28	8.11	17.97	7.09	14.28	10.39	9.00	8.24	4.68	10.64	5.97	11.08	7.91	8.58	7.33	7.48
June	29.59	17.10	26.58	19.68	19.42	14.17	8.61	8.24	12.26	17.24	17.86	13.58	10.77	10.70	14.15	14.40
July	1.00	4.89	7.26	1.77	1.68	4.80	10.75	7.54	11.94	9.82	5.93	5.23	6.11	4.35	10.85	3.83
August	1.05	1.70	0.79	2.12	1.44	0.18	2.60	0.82	7.55	0.72	3.46	1.74	4.87	1.24	0.46	0.87
September	2.68	19.56	5.94	6.09	13.10	6.54	6.60	10.95	12.65	8.93	6.98	8.06	6.13	10.05	5.74	7.48
October	9.15	10.79	8.60	10.25	7.84	7.74	8.65	8.98	4.15	5.37	6.85	4.49	6.68	7.91	8.34	8.34
November	6.92	2.72	8.90	11.23	3.17	4.96	5.35	4.87	3.68	3.82	4.89	4.50	5.84	4.09	3.22	6.84
December	4.82	4.60	1.48	5.40	1.30	2.31	1.36	2.14	0.52	1.65	1.28	0.55	2.52	1.08	2.08	0.72
Total	88.77	85.83	84.96	74.14	73.38	70.82	70.61	68.61	67.83	67.39	67.15	67.14	65.11	64.45	62.51	61.39
No. of Rainy Days (.01 inch or more)	86	114	189	169	—	139	119	116	121	159	133	135	128	117	125	—
Highest previous rainfall	—	—	109.65	95.03	—	79.90	73.62	95.07	100.58	—	—	—	75.19	—	77.91	—
Lowest previous rainfall	61.63	—	47.64	48.22	—	45.77	—	46.27	48.87	65.18	—	—	53.42	—	45.55	—

TABLE III.—*continued.*

1926.—*continued.*

Month.	17 Mpraeso.	18 Nkawkaw.	19 Mampong (Ashanti).	20 Mansu.	21 Tikrom.	22 Wenchi.	23 Mpennasa.	24 Seysie (Butre).	25 Kumasi.	26 Wiawso.	27 Koforidua.	28 Ho.	29 Ejura.	30 Kete Kratchi.	31 Asamankese.	32 Sunyani.
January	.09	0.00	0.00	2.85	.00	.00	1.73	0.79	0.23	0.14	0.03	1.72	.00	.00	0.97	.00
February	1.21	1.20	1.65	0.53	0.07	0.58	4.48	3.14	1.91	0.03	5.06	1.01	.00	.00	0.87	.00
March	6.60	6.85	2.70	2.79	4.92	3.38	3.20	2.27	4.94	3.55	5.32	3.38	5.23	2.01	5.03	5.09
April	8.48	7.65	9.52	3.84	6.29	7.29	2.68	2.65	7.24	4.46	4.32	8.04	5.27	3.28	4.52	4.57
May	6.08	5.05	12.97	7.09	6.84	10.28	11.95	16.76	9.61	3.37	3.84	7.34	3.39	5.96	5.84	5.54
June	8.04	7.50	9.79	16.55	12.45	13.78	21.30	17.45	11.73	14.17	15.46	10.23	12.89	13.40	9.29	7.61
July	6.57	10.05	4.70	2.25	5.72	3.12	1.79	2.29	4.69	6.10	1.52	4.36	4.95	11.27	3.40	6.37
August	5.10	2.95	0.94	1.40	0.98	2.25	0.44	0.48	2.12	1.93	0.35	1.67	3.25	2.00	1.44	2.00
September	7.29	7.05	9.65	9.09	8.82	11.63	3.02	3.05	2.79	7.23	4.95	6.46	9.39	7.87	5.88	11.89
October	5.51	7.45	4.58	5.85	8.16	4.75	5.10	4.23	5.40	5.00	5.23	4.02	4.78	4.01	6.30	6.36
November	2.49	3.40	3.07	4.60	4.51	0.99	1.85	3.57	4.20	5.60	5.64	2.95	2.79	1.06	5.63	1.02
December	3.48	1.53	0.39	2.65	0.61	0.20	1.42	1.62	2.29	5.29	2.25	0.98	0.17	0.83	2.26	0.50
Total	60.94	60.68	59.96	59.49	59.37	58.25	58.96	58.30	57.15	56.87	53.97	52.16	52.11	51.69	51.43	50.95
No. of Rainy Days (.01 inch or more)	112	—	—	85	—	87	87	130	136	125	100	96	96	91	134	78
Highest previous rainfall	85.26	—	—	83.70	—	60.95	60.27	58.96	70.40	70.44	—	—	80.75	60.41	—	69.47
Lowest previous rainfall	57.55	—	—	54.46	—	—	—	—	40.07	40.14	51.78	49.77	47.45	43.61	77.47	41.30

TABLE III.—*continued.*

1926.—*continued.*

Month.	33 Begoro.	34 Angu.	35 Peki Blengo.	36 Oda.	37 Nsawam.	38 Aburi.	39 Hemang.	40 Bekwai.	41 Yendi.	42 Tamale.	43 Asuansi.	44 Odumase.	45 Salaga.	46 Inchaban.	47 Adjua.	48 Kpedshu.
January	.00	1.45	.00	.00	0.45	0.45	0.30	.00	.00	.00	0.60	.00	.00	.063	.066	0.92
February	0.41	0.61	1.78	0.87	1.23	1.25	2.02	.00	0.03	.00	1.90	0.15	.00	0.89	0.50	0.15
March	5.24	2.66	2.00	6.18	4.39	4.57	6.50	4.25	0.98	1.75	4.84	6.17	2.08	3.98	1.50	3.98
April	6.17	1.76	6.97	4.89	2.63	2.86	7.41	6.50	3.97	0.95	1.34	3.94	3.45	1.78	1.42	7.19
May	8.01	7.04	9.78	7.39	5.71	5.79	.00	7.25	10.46	6.46	7.07	4.34	7.07	5.36	11.20	4.64
June	7.62	16.00	6.42	8.67	15.89	13.28	.00	9.00	3.94	4.56	12.40	7.82	6.54	18.40	13.81	6.23
July	5.57	1.50	11.26	0.48	1.54	2.89	.00	4.00	3.71	9.91	0.79	2.15	7.38	1.70	0.89	1.07
August	1.01	0.15	2.17	0.64	0.30	0.49	0.96	0.85	7.98	10.67	0.94	1.12	7.67	0.45	0.17	1.16
September	6.68	6.28	2.29	6.89	8.17	7.97	6.84	5.70	11.46	8.28	4.01	10.48	6.34	3.25	3.99	2.20
October	4.72	5.98	2.82	5.54	5.48	4.30	8.97	5.47	3.44	1.17	5.00	4.54	2.77	2.22	3.93	2.99
November	3.60	3.18	3.22	6.65	2.32	2.46	9.02	2.34	0.15	0.68	2.28	2.54	.00	2.01	1.52	8.57
December	1.40	2.97	0.78	0.87	0.90	1.44	5.02	0.85	.00	0.27	2.72	0.18	0.12	0.71	1.42	0.97
Total	50.43	49.58	49.49	49.07	49.01	47.75	47.04	46.21	46.12	44.70	43.92	43.43	43.42	41.38	41.01	40.07
No. of Rainy Days (.01 inch or more)	134	80	54	118	—	102	89	91	56	92	122	71	89	—	105	71
Highest previous rainfall	72.86	—	68.46	83.75	—	73.16	85.86	104.90	67.12	61.77	74.17	49.77	64.52	—	49.03	51.95
Lowest previous rainfall	—	—	36.33	43.61	—	32.09	58.64	53.64	—	32.36	35.62	—	37.79	—	36.81	—

TABLE III.—*continued.*

1926—*continued.*

New Stations.

Month.	49 Zuarungu.	50 Akuse.	51 Sekondi.	52 Wa.	53 Keta.	54 Abra.	55 Saltpond.	56 Achimota.	57 Accra.	58 Labadi.	59 Atuabo.	60 Asromaso.	61 Effiduase.	62 Adeja.		
January	.00	0.07	0.37	.00	0.13	0.26	0.31	1.28	0.23	0.17	Opened July 1st, 1926.	Records begin on July 1st, 1926.	Records begin on July 1st, 1926.	Opened on October 1st, 1926.		
February	.00	0.37	0.90	.00	0.78	1.32	0.36	0.60	0.24	0.21						
March	.00	3.14	2.21	1.27	0.20	2.15	1.62	2.60	0.49	0.70						
April	4.46	3.08	1.12	1.26	3.66	0.77	2.38	1.00	0.32	0.71						
May	4.91	6.92	5.98	5.08	3.46	5.29	2.74	5.10	1.67	2.61						
June	5.00	9.48	10.13	3.10	5.48	4.95	8.73	2.45	1.66	1.77						
July	4.98	0.73	0.40	4.82	1.56	1.10	2.44	1.14	0.75	0.40	1.70	5.00	6.58			
August	10.06	0.41	0.24	7.14	.00	.00	0.03	0.04	.00	.00	.00	1.07	2.04			
September	7.43	2.06	3.55	5.50	6.81	2.16	1.04	3.37	2.40	1.90	6.60	5.41	5.34			
October	0.75	5.57	2.76	0.32	4.16	5.89	2.89	1.80	1.93	1.73	8.65	8.33	4.68	3.40		
November	1.00	1.34	4.24	0.59	2.63	2.63	3.96	0.47	0.86	0.58	14.92	2.48	3.62	5.48		
December	.05	2.14	1.08	.00	.00	0.76	0.15	1.15	0.29	.00	3.13	0.94	1.77	4.13		
Total	38.59	35.31	32.98	29.08	28.87	27.28	26.65	21.00	10.84	10.78	35.00	23.23	24.03	13.01		
No of Rainy Days (.01 inch or more)	61	70	105	62	35	67	44	40	53	27	51	77	73	32		
Highest previous rainfall	51.62	58.98	57.76	50.71	51.44	34.18	43.80	24.09	44.20	36.87	—	—	—	—		
Lowest previous rainfall .. :	37.93	35.14	33.80	30.65	13.88	—	24.38	—	15.87	—	—	—	—	—		

THE GOLD COAST AGRICULTURAL AND COMMERCIAL SOCIETY.

This is a semi-official body of which the Director of Agriculture is *ex-officio* Chairman. The Society publishes a quarterly journal obtainable from the Secretary, (P.O. Box 206, Accra).

PUBLICATIONS OF THE DEPARTMENT.

PAMPHLETS.

Report on the Cocoa Industry of Ecuador	1920.
Notes on some exhibits displayed at Shows	1922.
Report on San Thome Cocoa pest (Heliothrips)	1923.
Prospectus of Kumasi Agricultural and Forestry Training Centre	1925.

LEAFLETS.

1.	Cotton	Nov., 1924.
2.	Corn Smut	Dec., 1924.
3.	Notes on Cocoa and Corn Smut Posters	Dec., 1924.
4.	Diseases of Corn	Jan., 1925.
5.	Notes on the Cultivation of European Vegetables	April, 1925.
6.	White Spot on Cocoa	June, 1925.
7.	Notes on Oil Palm Planting	April, 1926.
8.	Address to Chiefs (Plants Pests Ordinance)	July, 1925.
9.	Oil Palm Planting	Sept., 1926.
10.	Corn Storage	Oct., 1926.

POPULAR POSTERS IN COLOUR.

Preservation of the Oil Palm (Black print).

No. 1.	Why you should get rid of White Thread.
,, 2.	Treat your cocoa trees well.
,, 3.	What Sankonuabe or Akate does.
,, 4.	Thrips is your enemy.
,, 5.	Cocoa Mosquitoes.
,, 6.	Do not cut down all the Forests.
,, 7.	Forests are good for cocoa.
,, 8.	Remove sick cocoa pods quickly.
,, 9.	Black pods are your enemy.
,, 10.	£5 is better than £1.
,, 11.	Foolish farmers neglect disease.
,, 12.	Injury some insects do.
,, 13.	Corn Smut.

BULLETINS.

No. 1.	Control of Termites or White Ants in Buildings.	Oct., 1925.
,, 2.	Rainfall of the Gold Coast.	Jan., 1926.
,, 3.	Preliminary study of the life history of Sahlbergella.	June, 1926.
,, 4.	Yields of Cacao on Experiment Stations.	April, 1926.
,, 5.	Collar Crack of Cacao	Jan., 1926.
,, 6.	Economic Significance of Cocoa Pod Diseases	Jan., 1927.